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CONTENTS

NO. 1 *JANUARY* 1937

THE CORAL ISLANDS AND ASSOCIATED FEATURES OF THE GREAT BARRIER REEFS. By J. A. STEERS . . 1

THE PRE-COLUMBIAN DISCOVERY OF AMERICA. By JAIME CORTESÃO 29

THE SAIDMARREH LANDSLIP, SOUTH-WEST IRAN. By J. V. HARRISON AND N. L. FALCON 42

THE CRATER OF NYAMLAGIRA. By I. MITFORD-BARBERTON, A.R.C.A. 48

SOME NOTES ON CONVENTIONAL SIGNS FOR TOPOGRAPHICAL MAPS. By LIEUT.-COL. F. J. SALMON . . 50

THE COOK MEMORIAL AT POINT VENUS, TAHITI . . 54

GLACIOLOGY OF THE GREENLAND ICE-CAP: Review by MICHAEL SPENDER 59

REVIEWS. *EUROPE:* Hochbulgarien. II. Sofia. Bulgaria, past and present. Les Grands Causses. A geography of Europe. Walking in Dorset. Walking in Cornwall. Roman Britain and the English settlements. The old towns of England. The parish churches of Norfolk and Norwich. The Mesolithic settlement of Northern Europe. In the heart of Europe. Over Tyrolese Hills. Portugal. *ASIA:* Ancient irrigation works in Ceylon. The new Mongolia. Cambodian glory. *AFRICA:* Land without shade. The paradise of fools. Unknown Liberia. Durban. The birds of tropical West Africa, with special reference to those of the Gambia, Sierra Leone, the Gold Coast and Nigeria. Zambezi days. *NORTH AMERICA:* An illustrated manual of Pacific Coast trees. The birth of Western Canada. Steel of Empire. Amerikanische Landschaft. *AUSTRALASIA AND PACIFIC:* Stone-age Bushmen of to-day. And far from home. Agricultural organization in New Zealand. *CARTOGRAPHY:* Orbis Arctoi Nova et Accurata Delineatio, auctore Andrea Bureo Sueco 1626. Geodetic operations in the United States, Jan. 1st, 1933 to Dec. 31st, 1935. *ECONOMIC AND HISTORICAL GEOGRAPHY:* World immigration, with special reference to the United States. Le pétrole et son économie. *GENERAL:* Isles of the Seven Seas. Geographic disarmament. A commercial geography. Elements of geography. The complete book of Ski-ing 62

THE MONTHLY RECORD: Early maps of Scotland. Khairpur State, Sind. Gravity measurements in East Africa. Water supply in the Wheat Belt and Kalgoorlie Regions, West Australia. Lady Julia Percy Island, Western Victoria. Soil drift in South Australia. Origin of submarine troughs. Icelandic-Danish Expeditions to Vatnajökull 90

MEETINGS: Session 1936–1937 96

MAPS:

Fife Island 15

The Saidmarreh landslip 44, 46

Point Venus, Tahiti 58

Queensland Coast and adjacent reefs . . . . *following page* 96

PHYSIOGRAPHY OF THE REGION TO THE WEST AND SOUTH-WEST OF LAKE RUDOLF. By ARTHUR M. CHAMPION 97

THE CORAL ISLANDS AND ASSOCIATED FEATURES OF THE GREAT BARRIER REEFS. By J. A. STEERS . . 119

A LINGUISTIC MAP OF WALES ACCORDING TO THE 1931 CENSUS, WITH SOME OBSERVATIONS ON ITS HISTORICAL AND GEOGRAPHICAL SETTING. By D. TREVOR WILLIAMS 146

NEW JOURNEY TO THE WESTERN SAHARA, 1935–1936. By THEODORE MONOD 152

LAND UTILIZATION IN ENGLAND AT THE END OF THE EIGHTEENTH CENTURY. By GORDON EAST . . . 156

REVIEWS. *EUROPE :* A geography of Europe. No longer Poles apart. Scrambles amongst the Alps. *ASIA :* India's mineral wealth : A guide to the occurrences and economics of the useful minerals of the Indian Empire. *AFRICA :* Journey without maps. *NORTH AMERICA :* Die räumliche Gliederung der Landwirtschaft im nördlichen Kalifornien. The kingdom of Saguenay. *AUSTRALASIA AND PACIFIC :* The odyssey of a digger. *POLAR REGIONS :* Antarctic discovery : The story of the Second Byrd Antarctic Expedition. *PHYSICAL AND BIOLOGICAL GEOGRAPHY :* Notes on phenomena of a geophysical nature. Handbuch der Klimatologie. Band I, Teil B : Die klimatologischen Elemente und ihre Abhängigkeit von terrestrischen Einflüssen. Band I, Teil C : Das geographische System der Klimate. Band I : Titel, Vorwort, Inhalt, alphabetisches Sachregister. Handbuch der Klimatologie. Band II, Teil J : The climates of North America. *CARTOGRAPHY :* Map making. *ECONOMIC AND HISTORICAL GEOGRAPHY :* Scott of the Shan Hills : Orders and impressions. Indies adventure : The amazing career of Afonso de Albuquerque. Georg Wilhelm Steller : The pioneer of Alaskan natural history. *GENERAL :* Harpooner : A four-year voyage on the barque *Kathleen*, 1880–1884 . . 173

THE MONTHLY RECORD : Summer floods in Sonoyta Valley, Mexico. Glaciation of the Bantry Bay District. Rainfall map of Yugoslavia. Bibliographie géographique internationale, 1935. Recent geographical indexes. Monographs on economic geography of Poland 188

OBITUARY : John Hardwick Reynolds 191

MEETINGS : Session 1936–37 192

MAPS :

Distribution of the Welsh language 148
The Western Sahara 153
Land utilization in Middlesex 158
Land utilization in Wiltshire 164
Land utilization in Somerset 168
Turkana Province, Kenya Colony . . . . *following page* 192
Queensland Coast and adjacent reefs . . . *following page* 192

THE FIRST CROSSING OF ANTARCTICA. By LINCOLN ELLSWORTH 193
CLIMATIC CYCLES. By PROFESSOR D. BRUNT 214
THE ARUN RIVER DRAINAGE PATTERN AND THE RISE OF THE HIMALAYA. By L. R. WAGER 239
THE BRITISH GRAHAM LAND EXPEDITION, 1934–37. By F. D. 250
A NOTE ON THE OXFORD UNIVERSITY ELLESMERE LAND EXPEDITION, 1934 254
PEARY'S JOURNEY TO THE POLE: Review by A. R. H. and J. M. W. 255
THE VALLEY OF THE LOWER MEUSE: Review by DAVID L. LINTON 260
THE LAST OF THE ZERZURA LEGEND: Review by R. A. BAGNOLD 265
REVIEWS. *EUROPE:* Under Jane's wings. The Peace Settlement in the German Polish borderlands. Du nouveau sur Idrīsī. *ASIA:* Palestine on the eve. Archaeological history of Iran. The ascent of Mount Stalin. The English factories in India. The Snellius-Expedition in the eastern part of the Netherlands East-Indies, 1929–1930, Vols. II, V. The march of Japan. Japanese trade and industry—present and future. The industry and trade of Japan. New maps of the Chinese Provinces. Comptes-rendus de onze années (1923–1933). *AFRICA:* Coconuts and créoles. The Cambridge History of the British Empire. The Cape-to-Cairo dream: A study in British imperialism. *NORTH AMERICA:* Amérique septentrionale. *CENTRAL AND SOUTH AMERICA:* Land of to-morrow: A story of South America. *AUSTRALASIA:* Pacific relations: The races and nations of the Pacific area and their problems. *PHYSICAL AND BIOLOGICAL GEOGRAPHY:* Great earthquakes. Geographische Kausalität. *CARTOGRAPHY:* Map of Roman Palestine. *ECONOMIC AND HISTORICAL GEOGRAPHY:* Die Vorherrschaft der weissen Rasse. An introduction to the bibliography of Captain James Cook, R.N. Captain James Cook. Will Mariner: A true record of adventure. *GENERAL:* Elizabethan seamen 269
THE MONTHLY RECORD: The King's Accession and the Royal Patronage. Award of the Geographical Essay Prize. The Population of Berlin-Brandenburg. The cartographical work of Grazioso Benincasa. Climatic change in the Alps. Trade between the Roman Empire and the Free Germans. The accident to the O.U. Greenland Expedition, 1935. A rural economic survey of Siam. Tropical plants and world trade. International bibliography of geodesy 290
OBITUARY: 295
MEETINGS: Session 1936–37 296
MAPS:
Figures to illustrate Prof. Brunt's paper 214, 216, 217, 219, 220, 226, 228, 229
Position lines from Peary's observations 258
First crossing of Antarctica . . . . . *following page* 296
Drainage areas of the Arun and Tista . . . . *following page* 296

THE MOTOR ROUTE FROM PEKING TO KASHGAR. By SIR ERIC TEICHMAN, K.C.M.G., C.I.E. 297

FROM THE BRAHMAPUTRA TO THE CHINDWIN. By E. T. D. LAMBERT 309

THE ECONOMIC DEVELOPMENT OF THE SOVIET ARCTIC. By H. P. SMOLKA 327

THE POPULATION OF BENGAL, ITS DISTRIBUTION AND CHANGES: A CONTRIBUTION TO GEOGRAPHICAL METHOD. By ARTHUR GEDDES, D. ÈS L. (MONTPELLIER), PH.D. . 344

REVIEWS. *EUROPE:* Environment and nation: Geographical factors in the cultural and political history of Europe. A study of industrial Edinburgh and the surrounding areas, 1923–1934. The archaeology of Sussex. Grenoble: Étude de géographie urbaine. På Skidor Och Till Häst I Vatnajökulls Rike. Borderlands of language in Europe, and their relation to the historic frontier of Christendom. *ASIA:* Euphrates exile. Southern India: Its political and economic problems. Les batailles pour l'Himalaya, 1783–1936. *AFRICA:* Le Delta du Nil: Étude de géographie humaine. Three deserts. Afrikafahrt: eine Frau bei den Negern Westafrikas. Revisiting my Pygmy hosts. *NORTH AMERICA:* Settlement and the forest frontier in Eastern Canada. Landnahme und Kolonization in Canada, am Beispiel Südontarios. Atlas of American agriculture. *AUSTRALASIA AND PACIFIC:* Savage civilization. Back in the Stone Age: The natives of Central Australia. *PHYSICAL AND BIOLOGICAL GEOGRAPHY:* Paläogeographie und Tektonik. *ECONOMIC AND HISTORICAL GEOGRAPHY:* Turbulent journey: A life of William Bligh, Vice-Admiral of the Blue. *GENERAL:* Gods of to-morrow: A journey in Asia and Australasia 369

THE MONTHLY RECORD: Foreshore erosion on the North Sea coasts of Holland. The port of Naples. The *Calcutta Geographical Review*. Rainfall along the Chinese coast. Hydrology of Ethiopia. Recession of Kilimanjaro ice-cap 388

MEETINGS: Session 1936–37 392

MAPS:

The Assam–Burma Border 311
Figures to illustrate Dr. Geddes' paper . 346, 348, 351, 352, 356, 357
The motor route from Peking to Kashgar . . . *following* 392

THE TENNESSEE VALLEY PROJECT. By GEORGE B. BARBOUR . 393

THE TRANSPORT OF SAND BY WIND. By MAJOR R. A. BAGNOLD 409

THE CORDILLERAN SECTION OF THE CANADA–UNITED STATES BORDERLAND. By STEPHEN B. JONES, University of Hawaii 439

RENEWED ACTIVITY OF THE GREAT GEYSER. By NIELS NIELSEN 451

THE ALLEGED PRE-COLUMBIAN DISCOVERY OF AMERICA. By G. R. CRONE 455

REVIEWS. *EUROPE :* A biography of Manchester. The preservation of our scenery. Beiträge zur Geologie der westlichen Mediterrangebiete. Albanian back-door. *ASIA :* Geologie von Asien. Les paysans du Delta Tonkinois : Étude de géographie humaine. Esquisse d'une étude de l'habitation annamite dans l'Annam septentrional et central. The wilderness of Zin. *AFRICA :* Desert encounter : An adventurous journey through Italian Africa. The Bornu Sahara and Sudan. *NORTH AMERICA :* Our natural resources and their conservation. Alone across the top of the world. Potlatch and totem, and the recollections of an Indian agent. *CENTRAL AND SOUTH AMERICA :* Battlefield of the gods : Aspects of Mexican history, art, and exploration. Sailing South American skies. *AUSTRALASIA AND PACIFIC :* The Red centre : Man and beast in the heart of Australia. Adventuring in coral seas. The Phantom paradise : The story of the expedition of the Marquis de Rays. *POLAR REGIONS :* Arctic journeys : The story of the Oxford University Ellesmere Land Expedition, 1934–5. Arctic adventure : My life in the frozen north. North of North Cape : The Arctic voyages of the "Norkap II." *PHYSICAL AND BIOLOGICAL GEOGRAPHY :* Plant and animal geography. Der Abbau der Gebirge. *ECONOMIC AND HISTORICAL GEOGRAPHY :* Sir Joseph Banks : His relations with Australia. Le Père de la Louisiane : Cavelier de la Salle. Lucie Duff Gordon, in England, South Africa and Egypt. *GENERAL :* High failure : Solo along the Arctic air route. The story of sail. The clear mirror : A pattern of life in Goa and in Indian Tibet. Escales autour du monde 461

THE MONTHLY RECORD : The Bianco Chart, 1448, and the "Pillars of Hercules." Jewish settlement in Ecuador. The Erciyas Dağı region of Anatolia. Point Pigott, Mount Kenya. The Saidmarreh landslip, south-west Iran : correction 485

MEETINGS : Session 1936–37 488

MAPS :

The Tennessee Valley 395
Figs. to illustrate G. B. Barbour's paper 397
Figs. to illustrate Major Bagnold's paper 411–436
Profile of Crowsnest Branch (Canadian Pacific Railway) 442
Percentage of British-born in total population 443
Canada–United States borderland . . . . . *following* 448
Fig. to illustrate Dr. Nielsen's paper 453
Map showing Stóri Geysir 454

NORTHERN NEW GUINEA, 1936. By A. J. MARSHALL . . 489

THE DADESSA VALLEY. By CAPTAIN A. DUNLOP . . . 507

THE GEOGRAPHICAL IDEAS OF ROBERT HOOKE. By E. G. R. TAYLOR 525

THE SINHARAJA RAIN-FOREST, CEYLON. By JOHN R. BAKER 539

HVITSERKR 552

REVIEWS. *EUROPE:* Great Britain: Handbook for travellers. London: A combined guidebook and atlas. London wall, through eighteen centuries. The islands of Ireland. Géographie de l'Europe. Castilian ochre. I saw Spain. Atti del XII Congresso Geografico Italiano, tenuto in Sardegna dal 28 aprile al 4 maggio, 1934. *ASIA:* Arabs of Central 'Iraq: Their history, ethnology, and physical characters. The story of the Stūpa. Afghanistan: A brief survey. Half the world is Isfahan. Land utilization and rural economy in Korea. *AFRICA:* Stone Age Africa: An outline of prehistory in Africa. More annals of Natal. *AUSTRALASIA AND PACIFIC:* Walkabout: A journey in lands between the Pacific and Indian Oceans. *POLAR REGIONS:* Icy hell: Experiences of a news-reel cameraman in the Aleutian Islands, Eastern Siberia and the Arctic fringe of Alaska. *ECONOMIC AND HISTORICAL GEOGRAPHY:* Fortune my foe: The story of Charles John Andersson, African explorer (1827–1867). The principles of economic geography. Raw materials or war materials? An atlas of empire. *GENERAL:* Britannia. Round the world without worries 557

THE MONTHLY RECORD: Medals and Awards 1937. Origin of the Great Lakes basins of North America. Dating volcanic explosions by tree rings in Lassen Park, California. A Woutneel map of 1602. The British Health Resorts Association's handbook . . . 572

OBITUARY: Arthur Winston Moore 575

MEETINGS: Session 1936–37 576

MAPS:

North-east New Guinea 491
Northern coast of New Guinea 498
Western Abyssinia 509
Dadessa Valley 515
Southern Ceylon 540
The Sinharaja rain-forest . . . . . *following* 542

FIGURE:

Leaves of dicotyledons 545

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THE CORAL ISLANDS AND ASSOCIATED FEATURES OF THE GREAT BARRIER REEFS: *A paper read at the Afternoon Meeting of the Society on 7 December 1936, by*

J. A. STEERS

1. Introductory

IN 1928 the Geographical section of the large expedition sent out to the Barrier Reefs in that year established the low wooded islands or island reefs as a specialized type of coral island. Circumstances at that time did not allow of a very careful examination of many of these islands, with the exception of the detailed mapping of Low Isles and Three Isles by Michael Spender and others. Sufficient however was then seen of several of these islands to make a more detailed investigation at a later date desirable. This was made possible by an invitation from Professor H. C. Richards, Chairman of the Great Barrier Reef Committee, to the writer to revisit the reefs from May to August 1936. The low wooded islands and the Bunker and Capricorn groups formed the main field of this new expedition, but, just as in 1928, a large number of related problems also called for further investigation as far as circumstances permitted. The 1936 expedition was a small one, consisting of Mr. F. E. Kemp, B.A., of Selwyn College, Cambridge, and the writer.[1]

It was important to examine all types of coral islands, and as these are mainly in the southern and northern parts of the reef area, an extensive cruise was inevitable. In all, the cruise extended over a total distance of 2643 sea miles; from Brisbane to Cape Direction and back to Bundaberg. In this time a very large number of reefs, coral islands, continental islands, and parts of the mainland coast were visited. It was not possible to spend more than twelve and a half weeks on the work, and as the average speed of our schooner was 7 to 8 knots, it will be seen that much time was used in travelling from place to place. This is unavoidable; the Barrier Reefs stretch for nearly 1200 miles along the Queensland coast, and comparative ideas can only be obtained from

[1] To avoid repetition, only occasional short references are made to the earlier report by the writer (*Geogr. J.* 74 (1929) 232–57, 341–70) and to Michael Spender's paper (*Geogr. J.* 76 (1930) 193–214, 273–97).

seeing all parts. The ordinary tourist visit to one section or another does not give any real idea of the reef area.

Weather conditions were far from favourable during about one-half of our cruise. It is a myth to think that calm conditions always prevail within the reefs. A liner may not notice the short sea set up by a south-easter in the narrow channel north of Cairns; a small boat feels it much more than the swell of the open ocean. In addition to a large proportion of strong weather, which somewhat restricted general operations, there was a fair amount of gloomy weather with very poor visibility. This made observation of the mainland coast difficult when sailing along it, and also limited the amount and type of photography that was possible.

These difficulties however were minimized by the kindness of Mr. T. L. Jones, of Brisbane, who most generously put his schooner, the *Cambria*, at our disposal. The *Cambria* was an excellent boat for the purpose, and she was our home during the whole cruise. Experience gained in 1928 showed that it was far better to avoid camping on islands: time is only wasted in erecting and taking down tents, etc. The *Cambria* has a maximum over-all length of 79 feet and excellent accommodation. She was under the command of Mr. A. Histed, of Brisbane, who, together with his engineer, J. McNaught, and mate, J. Porter, did everything they could to make the expedition a success. North of Townsville, Mr. D. Moynahan, whose knowledge, extending now over a long life, of the northern reefs is unique, joined us as pilot. His services were invaluable.

The financing of the expedition was made possible in a variety of ways, and I should like to take this opportunity of thanking most cordially those who helped. Generous grants by the Royal Society and the Royal Geographical Society were given in England, and the Great Barrier Reef Committee supported the expedition most liberally in Australia. The Worts Fund of Cambridge University, the Lindsey County Council, and Selwyn College made personal grants to Mr. Kemp. The Shaw, Savill, and Albion, and Peninsular and Oriental Shipping Companies kindly gave us return passages, and I should like to record my personal thanks to Captain Tickell, Commander of the P. and O. T.S.S. *Strathaird*, and the Purser, Mr. Aries, for the facilities they gave me on board to write the preliminary draft of this paper. The Queensland and New South Wales Government Railways provided essential land transport in Australia. The Admiralty, through the Hydrographer, Admiral Edgell, presented us with a complete set of charts of the whole area covered by reefs. These, together with a private donation and the loan of the *Cambria*, covered the cost of the entire expedition, which, incidentally, gained considerably as a result of the exchange problem! Surveying instruments were kindly lent to us by Professor Debenham and the Royal Geographical Society.

2. General

The innumerable reefs to which collectively the name "Great Barrier Reef" is applied stretch from Torres Straits to Lady Elliot Island. The distance from the mainland to the inner edge of the reefs varies a great deal. Off the Cape York Peninsula it varies from about 80 miles in the north to 25 or 30 miles off Port Stewart, situated in Princess Charlotte Bay. Off Cape Melville

the reefs are closest to the mainland, the distance being less than 10 miles. Southwards from this cape the reefs generally trend farther away from the coast until the northern end of the Capricorn Channel is reached. From this point southwards the Capricorn and Bunker Islands form a disconnected inner line 30–50 miles off the mainland, and Swain Reefs form an isolated and extensive reef zone 60 or more miles farther to the north-east. A glance at a large map of Queensland however will reveal these facts more clearly than a long description.

The reef area, the "barrier," and inner and isolated reefs, is itself of considerable width in most places. Much of the detail remains uncharted; from the point of view of navigation the outer and inner edges and the isolated reefs and islands in the steamer channel are essential. The intricate details of the individual reefs do not interest the liner: the close neighbourhood of reefs is to be avoided if possible. But the charts are often remarkably complete in details, and the work still continues. A careful inspection of the large-scale charts is essential to obtain any reasonable conception of what this "barrier" is like. The representation of parts of four charts in the folding map will afford some general ideas of the tremendous amount of detailed and arduous work that is necessary in a full survey, and it will also draw attention to the width of the reef area.

It is, from the technical point of view, rather unfortunate that the name Great Barrier Reef is commonly used. In no scientific sense is this strictly accurate. It was pointed out by the writer, and enlarged upon by Spender after the 1928 Expedition, that a great change takes place in the reefs off, approximately, Cairns. Reference to Fig. 6 in Spender's paper [1] clearly brings out this point. The 1000-fathoms contour closely follows the outer edge of the reefs to the south of Cooktown; it then sweeps northwards and outwards to include Osprey Reef, Lihou Reef, and Saumarez Reefs, *i.e.* 5 or more degrees of longitude away from the mainland coast. Spender called attention to the inadequacy of the 100-fathom line off Central Queensland as a definition of the margin of the Queensland Continental Shelf. In many parts of the globe this line does form a useful boundary, which seems to have a real geomorphological significance. But off parts of north-eastern Australia it seems more reasonable to take the 600-fathom or even 1000-fathom line as the continental edge. The reefs of the southern and central parts of the "Barrier" are well within the 100-fathom contour, and so often several hundreds of miles inside the 600- and 1000-fathom lines. In the north however the outer reefs correspond closely with the 100-fathom line and the depths increase rapidly to 1000 fathoms. This northern part, in fact, conforms with the ordinary views regarding a barrier reef. It is longer and probably wider than most such reefs. But south of Cairns the term "barrier" is inadequate. Instead, there is found a very large number of reefs, sometimes separated by wide, but usually by narrow, channels. They become almost individual units spread over a broad area and forming a most dangerous zone for navigation. The charting of all these reefs will require so much time that completion may never be reached. They are known only to a few who have visited them for *Beche-de-mer*, *Trochus* shell, or other reef products. It is interesting to note the legends which still appear

[1] *Op. cit.*, p. 274.

over some of these areas on the charts—"seen by the Ship Wansfell in her dangerous passage through the reefs, 1864," "high breakers seen by Flinders." Now that the general limits of these difficult areas are known, they are avoided by all except those who, for some reason or another, make special voyages to them. Regard them as water or land as you will, they are one of the few unmapped and even in some ways unexplored areas of the Earth's surface that yet remain.

To cover this multitude of reefs the Admiralty Charts use the phrase "Great Barrier Reefs." This is more expressive than the use of the word "reef" in the singular. They form a barrier, but not a "text-book" barrier, and the mere addition of the letter "s" is significant—not only for the reasons given. It must be remembered that between the outer reefs and the mainland there is an archipelago of islands made up of terrigenous materials. Often these are partly or wholly surrounded by fringing reefs, which must be distinguished from the barrier reefs. Then again, as shown in more detail in another section, one or two of the reefs in the Bunker and Capricorn Islands approximate to, and may be regarded as, atolls. Finally, there are also occasional fringing reefs found along the mainland coast. All this makes for complication in nomenclature, and even now the isolated reefs, so often crowned by a low-wooded island, that occur in the steamer channel have not been mentioned. These were once called pseudo-atolls, but the name is a bad one. They are merely ordinary patches of reef, without any true or even "pseudo" lagoon, which stand isolated both from the outer reefs and from the mainland.

A comprehensive name to cover all these varieties would be difficult to find. Following the lead of the Admiralty Charts, I would suggest that every one should use the phrase "Great Barrier Reefs."

To avoid repetition there is no need to give a description of the mainland coast. A short account was given in a previous report. For the same reason little need be said about the continental islands which fringe the coast. They are parts of the continent which have been separated by submergence, and usually occur in groups. Although not a great deal is known of their geology, it seems possible to draw definite trend-lines through many of them.[1] In a broad way the nature of the rocks of which they are composed varies with that part of the mainland off which they are situated. The important question of benching and related features on these islands and on the mainland is discussed separately.

From what has been said it will be understood that the ordinary lagoon within a barrier reef is here replaced by a sea which is, in the south, very wide. The prevailing wind in the northern area is the south-east trade, which blows from April to October. In the summer months both calms and north-west monsoon winds are experienced. This also is the cyclone season, and one or more parts of this coast usually suffer from their effects each year. The south-easter sets up at times a difficult sea for small craft, and for days on end it may blow as a stiff breeze or half a gale, rising at times to a moderate gale.[2] Owing

[1] Full references to the literature on this subject will be found in my previous report, *loc. cit.*

[2] Readers of Cook's Journal will find an interesting account of weather conditions from day to day. Our experiences were very similar, and we were there at much the same time of year.

Wilson Island

Wilson Island. Beach rock and boulders

to the varying trends of the coast, the wind often sweeps along, not merely across, large areas of the "lagoon," and consequently its effects are often considerable. In the central and southern parts conditions are rather more variable, but south-east winds are common. Relatively calm conditions are expected, even if not always experienced, in the winter half-year.

The general effect of these winds is to cause a northerly drift, more particularly north of Townsville, during the season of the south-easter. Often the ebb currents which would run southwards are outbalanced, so that at those times the northward-running current is merely slower than it is at the flood. Wind, waves, and tide, then, work largely together, and are responsible for a generally northward translation of beach material along the mainland, high islands, and reefs. It is noticeable that the great majority of high islands, and many purely coral islands, possess a spit of shingle or sand pointing to the north-west. This is the direct product of the action described.[1]

The tides at Low Isles have been described in some detail by Spender,[2] who was able to examine records extending over some months. The tropic tide experienced at that place holds good in a broad way over the whole area of the reefs. Visits made to reefs in the winter months are usually more helpful, because the low tides, when the reefs are uncovered, are then day tides, so that it is much easier to examine the reefs and to see more clearly their relation to the coral islands.

3. The Bunker and Capricorn Islands

These two groups of islands form the southern extremity of the reef area. They lie to the westward of the Capricorn Channel and are situated between 30–50 miles from the mainland. They are isolated, and can hardly be considered as part of the reefs proper. On the other hand, they include true coral islands and reefs on which no island, or at best only a sand-bank awash at high water, exists. Lady Elliot Island will be considered as one of them, although it is not a member of the Bunker Group. In all there are thirteen islands, twelve of which were investigated. Bad weather made it impossible to land on North Reef, but this was visited by the writer in 1928.

Whilst defining them precisely enough as names, the terms Bunker and Capricorn imply nothing more. As will be shown later, it is possible to draw a line through these islands separating those which are mainly formed of coarse shingle from those which are made up of sand. All of them possess many features in common. They are flat islands, usually covered with vegetation, and with the exception of One Tree Island, situated towards the lee side of individual reefs. Lady Elliot Island is barer than the others and is more isolated. They all stand near the edge of a submarine platform, so that the water within the islands seldom exceeds 30 fathoms, whereas eastwards of the outer islands the 100-fathom contour is not far distant. Goats have at one time and another been placed on several of them. MacGillivray and Rodway, writing in 1927,[3] speak of the havoc these animals have made of the undergrowth on Lady Musgrave Island. This fortunately is now cured, because

[1] See references given in 1929.
[2] *Geogr. J.* 79 (1932) 201–9.
[3] *Reps. Gt. Barrier Reef Committee*, vol. 3, 1931, p. 58.

Wilson Island. Pandanus palms

the herd has been much reduced, and it is now quite difficult to get about the island. A species of *Abutilon*, with other plants, forms a tangled undergrowth. On the other hand, on the larger Fairfax Island the goats now there have left no undergrowth at all.

Because it is possible to recognize two distinct physiographical groups in all these islands, one island typical of each will be described in detail and brief notes given of the others. Lady Musgrave Island may be taken as a fair representative of the shingle islands. Though there is a good deal of sand to be seen, there was a predominance of shingle, for the most part coarse. The present beaches of the island are mainly sandy, and, as is common in most islands in the reef area, there is a good deal of beach-rock. This is due to the lithification of the ordinary sand, resulting from the precipitation of calcium carbonate in a way not yet decisively explained, so that a hard rock formation is built. This has a considerable physiographical influence as it resists erosion to a marked degree, so that it is quite common to find old lines of this rock forming small capes or headlands, the spit or ridges of shingle that such rock once protected having been washed away. It should be borne in mind that the process of lithification seems to be limited to the space between high and low water, so that only a thin layer of rock is produced, and the whole spit, or beach, of sand is not hardened.[1]

Within Lady Musgrave Island there is a fair amount of sandy soil, enriched to some extent by guano, but much of this deposit has been removed in the past. As far as could be seen in natural or artificial hollows and sections, the main mass of the island is composed of coarse coral shingle which has been cemented together, presumably largely by rain-action, to form a hard conglomerate. This surface is, on the whole, level, though rather rough in detail. How far down this hard material extends is not known, but it possibly reaches the coral flat upon which the island rests.

This island, like all the others in these two groups, shows no conclusive evidence of any recent movement of sea-level. There are possible traces of raised platforms, but none which, in the writer's opinion, can be taken as final. For example, near the south-eastern corner of the island is a mass of high-standing conglomerate in the form of a narrow platform. The outer edge of this is suffering considerable wave erosion. The top of the platform is generally of the same height as that of the main mass of the island. But the platform is not above the reach of storm waves. This may be compared to a platform-like structure on Fairfax (larger) Island, about 12 feet above the average level of the reef flat and, like that at Lady Musgrave Island, stained brown, presumably by percolating water from the surface with its thin soils with some guano. But the "platform" can be explained adequately in another way. The whole thing, some 15 yards broad on Fairfax Island, is relatively flat, but is nothing other than piled-up storm shingle, subsequently lithified. Its level top represents the limit to which shingle is thrown, and its breadth indicates that newer ridges have been thrown up and on to older ones. That this has happened in nearly all islands is clearly seen from the dark, almost

[1] The many theories purporting to explain the origin of beach rock fail to give any complete explanation of its occurrence in this area. I am unable to suggest an alternative hypothesis.

black, colour of the old shingle as contrasted with the whiteness of the new. All the possible "platforms" observed in the Bunker and Capricorn Islands could probably be explained in this way. It would not be fair to state emphatically that various ledges of beach-rock or conglomerate do not, in any case, represent a recent vertical movement, but nothing was seen in these islands in any way comparable with the excellent platforms on the low-wooded islands in the northern area. This point, together with certain other features of the Bunkers and Capricorns, is reasonably interpreted as a result of their exposed position.

The individual maps will show the general appearance of Lady Musgrave and other islands more clearly than a lengthy description. They all conform to a simple pattern. Inside there is the vegetation-covered area: this may consist of creepers and bushes, or even of well-grown trees, as on Lady Musgrave Island. Outside is strand vegetation passing into beach, parts of which are lithified into beach-rock. The island is clearly differentiated from the reef except that it may be trailed out in one or more directions by long spits of sand and shingle below mean tide-level. Only in such places does it become difficult to say exactly where the island begins. Normally the sand edge on the reef is almost as clearly differentiated as is the letterpress on this page.

The essential formation of Lady Musgrave Island and the other members of the group to which it belongs is, then, coarse coral shingle now consolidated into a coral conglomerate. As there is little difference between the vegetation of the islands, a brief account of it will be deferred until the end of this section.

Lady Elliot Island is generally similar to Lady Musgrave Island. The differences are more apparent than real. Lady Elliot Island is very barren in appearance: there are two or three groups of wind-swept trees, and the rest of the surface is either bare or but meagrely covered with grasses and creeping plants. This enables the sub-structure to be clearly seen, and the fact that much of it is practically a hard coral limestone, due to the cementation of coral shingle, is instructive, as this is apparently the case in the more densely wooded islands. On Lady Elliot Island there are solution hollows, and the surface is in some parts a miniature karst. The edges of the island are composed of modern coral shingle cast up in hurricanes and storms. This rim often stands a little higher than the centre, partly because it is newer and has not settled, partly because guano has been taken from some of the interior, and partly due to the incidence of storm action—the highest existing rim usually being the newest.

Fairfax Island, or Islands, as there are now three and were two, show interesting contrasts. The largest, *i.e.* that to the north-east, is formed almost entirely of lithified shingle. The southern part is well forested, largely by *Pisonias*, but the goats have eaten away all the undergrowth. The remainder is a desert. It has been altered much by man in his search for guano, and only a few creeping plants are found. The structure is, in essentials, that of Lady Elliot Island. The remaining two islands were originally one a few years ago, but a cyclone caused the waves to breach a weak part, and so led to the three islands seen by us in May, 1936. The larger of these two is mainly composed of large fragments of coral shingle, often consolidated. Ridges of shingle extend into the body of the island, and are gradually flattening and settling.

The vegetation is helping to obliterate their individuality, and it may be that in a comparatively short time the island will resemble Lady Musgrave Island. The present third island is merely a sand-bank, and at one time must have formed a long sand-spit-like appendage to the island just mentioned.

The contrast between two islets on the same reef is better seen in Hoskin Island. Here the outer and smaller one conforms to the shingle pattern. It is almost entirely composed of shingle fragments arranged in ridges. The vegetation is thick, though there are few big trees. It gives the impression of being a newer island than, say, Lady Elliot Island, but this may be because of the vegetation and because our visit coincided with a wet period, so that all looked thriving and youthful. There is a relatively thick soil on the second island, which is thus difficult to penetrate on account of vines and creepers. Apart from its south-eastern end, where there is much sand and coarse shingle, I think that there is less coarse material than on the islands already described. Between the two islets there is a large patch of very jagged coral conglomerate rising up three to four feet above the reef-level. This is much eroded and presumably represents all that is left either of a former island or of a former connection between the two existing islets.

Wilson Island is small and covered with a fairly dense vegetation. The reef on which it stands is also small, and the island is made of a mass of coarse and finer material. It is doubtful if sand predominates over shingle. The weather side shows an excellent development of beach-rock, but this has been much broken up and large masses hurled higher up the beach, thus giving the aspect of a very coarse boulder beach. The exposed position of the island and the small size of the reef allow powerful waves to reach the island and produce this effect.

One Tree Island, the most exposed perhaps of all, is formed almost entirely of coarse shingle, many blocks exceeding a foot in diameter. There are occasional pockets of finer material. The outer ridges form a high and broad rim, but the interior is low and contains a pool of brackish water [1] surrounded by a flat of coral conglomerate thickly covered with *Sesuvium portulacastrum*. A pseudo-platform occurs along part of the weather side; the coarse shingle of the outer ridge has been combed down by wave action to form a kind of apron, which has been lithified and now closely resembles the lower promenade of the low wooded islands. The dip in this particular case is seawards, in contrast to the common inward dip of the material in the promenades of the low-wooded islands. At the far end of the reef on which One Tree Island stands there are several wave-built ridges of coarse shingle; these are awash at high water.

The remaining islands in these two groups are all sand islands. They differ but little from one another except in size. They are also rather better known, and some of them are regularly visited by tourists. North-West Island is the largest of them, but Heron Island may be taken as an example, as it is probably the best known. It is formed almost entirely of sand, which, on the weather side, is piled up into small dunes which soon merge into the general level of

[1] MacGillivray and Rodway state that this is the only breeding-place of mosquitoes in these islands (*loc. cit.*). The island was named during the voyage of the *Fly* on account of a conspicuous *Pandanus* tree.

the island, but give it a kind of rim on the exposed side. These dunes are practically entirely plant-covered, creeping plants, grasses, *Pandanus*, and *Casuarina* being commonest. The weather side of this and other islands also shows evidence of a certain amount of erosion. Whilst the dunes are forming there is also a certain amount of undercutting going on, so that it is normal to find minor cliffs in the dunes, and trees, partially or wholly uprooted, on the foreshore. On the lee side the beach slope is usually less steep and more evenly graded; there is no undercutting here except in occasional storms. The whole island is merely a flat-topped heap of sand; there are only quite minor variations in level. The soil, whilst obviously sandy, also contains a good deal of decaying vegetable matter and some guano. Hence the island is fertile and bears a dense vegetation with some well-grown trees. The undergrowth is also fairly dense. The surface of this and other similar islands is often pitted with the holes made by mutton birds (*i.e.* the short-tailed shearwater). The southern shore has a good development of beach-rock along it for nearly the whole length of the island. This is the normal beach-rock—lithified sands containing a few boulders of coral here and there. Here, as in most other cases, the strike of the beach-rock is approximately parallel to the trend of the beach, on which it forms a surface skin. Occasionally horns run out from the present beach, but when they were formed there was a beach or sand-spit in between them. Heron Island lies to the north-west of a large reef containing a lagoon which, in places, has several feet of water in it when the tide is out. It is hardly a true atoll reef, but the lagoon is deeper than usual in these areas.

North-West Island is very similar in structure and appearance to Heron Island. The main difference noticed was the marked absence, at the time of our visit, of beach-rock on the weather shore. It is true that this rock may be covered up by sand, but there seemed to be no continuous extent of it on the exposed beaches of this island. The exposed side shows a mild amount of erosion and dune formation.

Tryon Island is small and lies about 3 miles north-east from North-West Island. It is almost all sand, and carries a fair thickness of soil. The vegetation is thick. Beach-rock is well developed on the weather side, and at the north-western end of the island there is a marked ledge of this rock running out from the island. At one point sand has collected in dunes to a height of nearly 30 feet above the reef flat.

Erskine Island is another small sand island, on which the beach-rock is best developed on the side facing west and north-west. Much of the rock has been torn up by waves and piled up higher on the beach. The vegetation, whilst dense, does not consist of high trees. *Tournefortia* and *Scaevola*, with many creepers and grasses, form the bulk of it. The island lies on the southern side of the reef, so that its position is rather exceptional.

Mast Head Island shows similar features. Beach-rock, small dunes, and dune-cliffing are again seen on its weather side. But there is so great a likeness physiographically between all these islands that a description of one almost applies to all.

A word must be said about Wreck Island. It is long and narrow and orientated approximately north-east to south-west. Beach-rock occurs mainly on the weather side, where it has been broken and thrown higher up the beach.

This beach consists of sand and fine shingle, and low dunes have formed. At the northern end is a long, narrow spit of mixed sand and rather coarse shingle. This spit has been eroded and later extended. The vegetation is generally thick, big trees being found, but *Tournefortia* and *Scaevola* seem to be the commonest genera.

North Reef is a small sand island with low bushes. Conditions made landing impossible, but as far as could be seen from a partial rounding of the island, it is of the usual sandy type.[1]

The vegetation of these islands has been described by MacGillivray and Rodway,[2] and that of Mast Head Island by Longman [3] also in an earlier paper. Whilst there are slight differences noticeable on the several islands, the main genera are the same. On the outer zones of the shingle islands, especially, a trailing pea (*Canavalia obtusifolia*) was common. The convolvulus (*Ipomoea* spp.) is often found colonizing the sand. *Pandanus*, *Casuarina*, *Scaevola*, *Tournefortia*, and *Suriana* are common on the outer margin of the forested area. *Pisonia* gives a marked appearance to the forest area of several of the islands: other trees of this belt include *Celtis panniculata*, *Ficus opposita*, and *Pipturus argenteus*. Various grasses are found on all the islands.

There are also a few reefs without islands in these two groups. Occasionally a sand-bank is found on one or more of them (*e.g.* Wistaria Reef), but, as often as not, it is washed away and all that can be seen is a spread of sand and yellowish water on the reef covering the area where the bank once stood. Special mention must be made of Lady Musgrave reef and lagoon. So far as the writer knows, lagoons, in the true sense of the word, are rare in this region. Of all the islands visited, Lady Musgrave alone afforded an example of something akin to an atoll lagoon, and Fitzroy Reef of a reef-enclosed lagoon with no island. Future work may reveal true lagoons in many other individual reefs which make up the whole region. We made several soundings about the time of low water over an extensive part of Lady Musgrave Lagoon, and recorded depths of 3 to 5 fathoms quite commonly. The bottom was usually sandy. Towards the south-east the lagoon is shallower, with many large coral heads. Weather made entry through the narrow gap in Fitzroy Reef impossible, but this reef again is reputed to have, and certainly appears from a boat to have, quite deep water within it. There are also deep hollows in Fairfax Lagoon: we made a sounding at about mid-tide of 18 feet between the two main islands, but for the most part this reef, like most others we saw, dries out almost entirely at low springs. Soundings were also made in part of the lagoon in Pickersgill Reef, south of Cooktown. Two to three fathoms were recorded in several places at low water, but it is not by any means so like an atoll lagoon as is that of Lady Musgrave Reef. Future work may modify seriously these remarks.

It has been shown that the islands, including Lady Elliot Island, of the Bunker and Capricorn Groups fall clearly into two main categories—the coarse, shingle, conglomerate islands and the purely sand islands. There are possible transition cases, such as the inner islands on Fairfax Reef. The sandy islands are usually the inner islands; the shingle ones are for the most

[1] This is confirmed by my photographs taken in 1928.

[2] *Loc. cit.*

[3] *Proc. Roy. Soc. Queensland*, vol. 25, 1913, p. 17.

part the outer islands, but Wreck Island, to some extent Wilson Island, and North Reef are exceptions. These are sandy islands on the outer edge of the groups. The next generalization that can be made is that the islands, with the marked exception of One Tree Island, usually lie near the lee side of reefs. In this they resemble the cays of the low wooded type later to be described.

All these islands, shingle or sand, owe their formation to wave action. The waves erode the reefs, and if circumstances are favourable a certain amount of the eroded material, instead of being spread over the reef-flat or carried away from it altogether, accumulates in a pile. As described in 1929, such accumulations are favoured near the lee side of reefs because it is here that the waves, sweeping round from the seaward side of the reef, meet and help to prevent all the loose material being swept off the reef. I am of the opinion that this process is most marked in sandy and relatively fine material, which would be most likely to travel farthest, and the meeting waves would also be better able to restrain this finer stuff. At first a mere heap of sand would appear—the sand-bank awash at high water. Given favourable conditions, especially the absence of severe storms, for a sufficiently long period, this bank would gradually emerge and become a piece of dry land. It is then only a matter of time, probably short, before seeds are brought to it by birds, currents, winds, even men, and once these take root the plants themselves help to bind the sand and to catch any that may be blown from off the reef when exposed. Relative stability of a nucleus having been obtained, growth probably goes on fairly quickly until the island has attained such a size that it is in equilibrium with the size of the reef upon which it stands and with the various agents (waves, tides, winds) acting upon it. Storms will give it a chequered growth, and the sand-bank may have to suffer many flattenings before it can emerge as an island. The true islands also have to suffer much, but, once they have attained a reasonable size and got a good covering of vegetation, they may be considered permanent in position, but not in shape.

The formation of the shingle islands is due to a similar process. They are always in exposed positions; a sand island may be so, but it is usually rather better protected. The greater wave power on the outer reefs, acting in the same way as the rather lesser waves on the inner reefs, is responsible for the early formation and gradual growth of the shingle islands. Their position on the reefs may possibly be accounted for in the same way, but one must bear in mind the exceptional case of One Tree Island which is close to the exposed face of the reef. No precise reason for this can be given, but it may be suggested that as long as wave action, be it the result of a storm or of normal conditions, piles up a nucleus around which material can accumulate, an island is likely to evolve. There seems to the writer no definite reason why such a nucleus, possibly around large boulders (*i.e.* negro-heads in Flinders' use of the term) should not occur on any part of a reef-flat. The fact that islands usually occur to leeward may be due to the fact that boulders are often commonest on the lee rim of reefs and thus may help to prevent sand running completely off the reef. Such a possibility would easily work in with the method of formation suggested earlier. But waves can, and do, form sand or shingle banks on a reef irrespective of any nucleus such as a boulder. Whatever may be the origin of One Tree Island, its position on the reef is exceptional, but the

shingle banks, which are not yet islands, on the lee of the same reef are the corresponding features to the other islands. Wilson, Wreck, and North Reef Islands are exceptions also, in that they are primarily sand islands on the outer, exposed reefs. There is no obvious explanation of this, and the fact that they are exceptions demonstrates once again the importance of not generalizing too readily on coastal phenomena. There is however no doubt that all the islands are first the product of erosion of the reef on which they stand and secondly due to wave construction.

Large boulders of coral rock, sometimes isolated, sometimes in ridge form, are usually found to leeward of these southern reefs. The explanation for this is probably the same as that given for the same phenomenon farther north, namely, that in the relatively sheltered water on the lee sides of reefs, large cauliflower-like masses of coral grow on fairly thin stems. These masses may be broken off in severe storms and cast up on to the reef. The rougher water on the windward side may prevent such masses forming there. It may also be remarked that the coral shingle of these islands, as well as of others south of Townsville or even Cairns, usually consists of large and small rounded lumps. There is relatively little finger-like shingle found in these places. This, again, may be due to exposure. Relatively fragile forms, such as stag's horn coral, may be more closely associated with the calmer waters farther north. This is merely a suggestion; more information is wanted.

As will be more fully described in connection with the cays and the low wooded islands, the formation of beach-rock on any coral island off the Queensland coast is a stabilizing factor, and the permanency of an islet probably depends more on this factor than on any other.

It is also important to note the absence of ridges or ramparts of shingle on the weather side of these reefs. In this they differ from the low wooded type. I am in general agreement with Yonge's[1] suggestion that exposure to the open Pacific prevents the formation of ramparts on these islands. It is however relevant to recall attention to the anomalous position of One Tree Island and the conglomeratic nature of others of these islands in this connection.

4. Sand Cays

The sand cays are the simplest type of islands found in the Barrier region. It is true that the Bunker and Capricorn Islands are in one sense only cays, but their position and the fact that some of them are entirely shingle formations put them into a separate class.[2]

Broad generalizations usually lead to confusion, but it may be stated that sand cays are commonest on the inner reefs of the outer barrier series. They are not confined to this strip: at least eighteen[3] are marked on the Admiralty Charts on the outer side of the Barrier reefs. These were not visited. As pointed out above, it is not easy to define the inner edge of the outer barrier with any great precision. This is particularly the case south of Cairns and

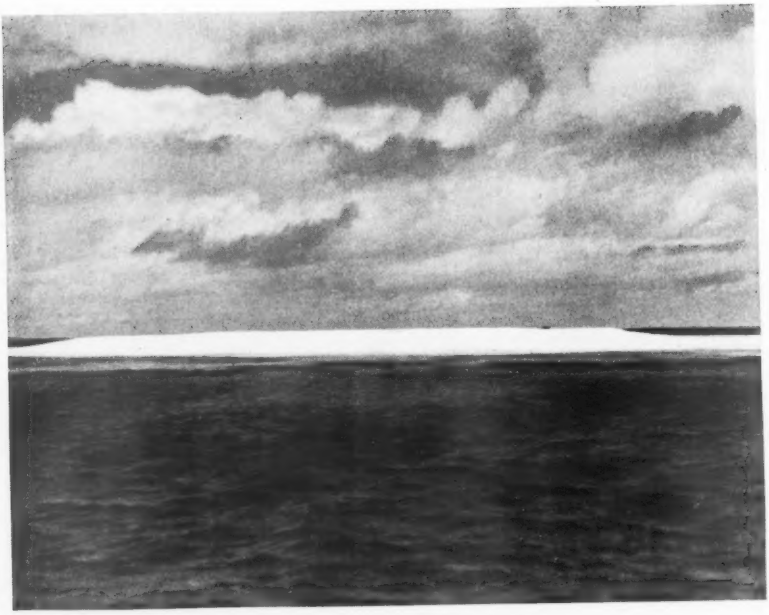
[1] 'A Year on the Great Barrier Reef,' Putnam's, 1930, p. 201.

[2] Maps of Heron Island and Lady Musgrave Island are given, and also of Fife Island. For other sand cay maps see 1929 paper; further maps of cays were made in 1936, but space forbids their insertion here.

[3] Including sand-banks awash at high water.

One Tree Island. Reef flat and shingle

Great Keppell Island. Lower bench in contorted rocks



Sand cay on Sudbury Reef

Ingram Island. Strand vegetation

Townsville. But Bushy (Red Bill) Island, situated some 60 miles off Mackay, may be included. There may be other cays situated in similar positions, but much of this area yet remains to be charted in detail. Hence any purely sand islands north of the Bunker and Capricorn Groups and situated on the Barrier Reefs, no matter on what part of them, are treated here as sand cays in the strict meaning of the term.

At first sight a sand cay is not very interesting: it is merely a flat heap of coral sand mixed with a certain proportion of shells and foraminifera and piled up on the lee side of a reef. Cays are unstable structures, and a small one may be swept away by a cyclone. The only difference between them and sand-banks awash at high water is one of degree. A large number of reefs carry some sand; this may be spread out flat or piled up into a low heap covered at high water. It is only when such a heap has grown to such a height that it remains dry at high water that the term "cay" is applicable.

Waves breaking on a reef gradually produce much sand, which collects in the innumerable slight hollows of the surface. Parts of the surfaces of reefs are often dead and sanded over. In course of time the waves tend to shift much of this material to, approximately, the north-western end of a reef. The south-easterly winds and waves are both prevalent and dominant, and it is to their combined action that this shifting and, as will be shown later, constructive action is due. It is probably true to say that every reef is potentially the bearer of a cay or sand-bank; conversely it is impossible to say why such banks are not more common.[1] But the interplay of various factors gives some insight into the matter. In most cases it may be assumed that the sand, produced in the first place by wave erosion, will be sooner or later swept completely off the reef into the deeper water under its lee. Most reefs are covered by several feet of water at high tide, and so it is not difficult to appreciate this point. But where conditions are such that the waves, coming in from the usual south-easterly direction, are able to sweep round as well as over the reef, another factor comes in. It is more than common to notice the meeting of the two sets of waves off a sand-bank. "Where there is a sand-bank there is a roll" is a fairly safe conclusion if an anchorage is made off such a bank in windy weather. The meeting of the two sets of waves leads to a slight constructive effect, because, after meeting, the waves run up the reef and bank and so to some extent allow the sand, which would normally be washed away, to pile up in the form of a cay. Observations of several such banks, both in 1928 and 1936, led the writer to this, and only this, conclusion. The difficulty is to explain the absence of cays in apparently favourable places rather than to explain their presence elsewhere. Their absence is often more apparent than real, because a large number of reefs do carry a spread or low patch of sand on their lee sides. This merely means that conditions have not favoured the growth of such a bank into an island. In other cases one may regard a maze of reefs as forming, for this purpose, one large reef. The individual reefs are separated only by narrow and tortuous channels in which the encircling waves have little power. Hence, if a cay is built it may stand to leeward of the group of reefs. In other cases exposure may be such that it is normal for all the sand gradually to be swept off the reef into deeper water, whereas on a

[1] The level of reefs may control this matter. See sections 7, 11.

protected reef wave action may not be sufficient to lead to the construction of a bank. It is not, then, surprising that true cays are comparatively rare, the more so as the growth of a sand-bank into a cay must be a hazardous process.[1] A simple sand-bank or cay has no real stability, because the much larger waves during a cyclone may sweep completely over it, flatten it down, and wash most, if not all, of it away. Normal conditions later may lead to a gradual rebuilding. Rough weather is no rarity in this region, and such changes as just outlined take place not infrequently.

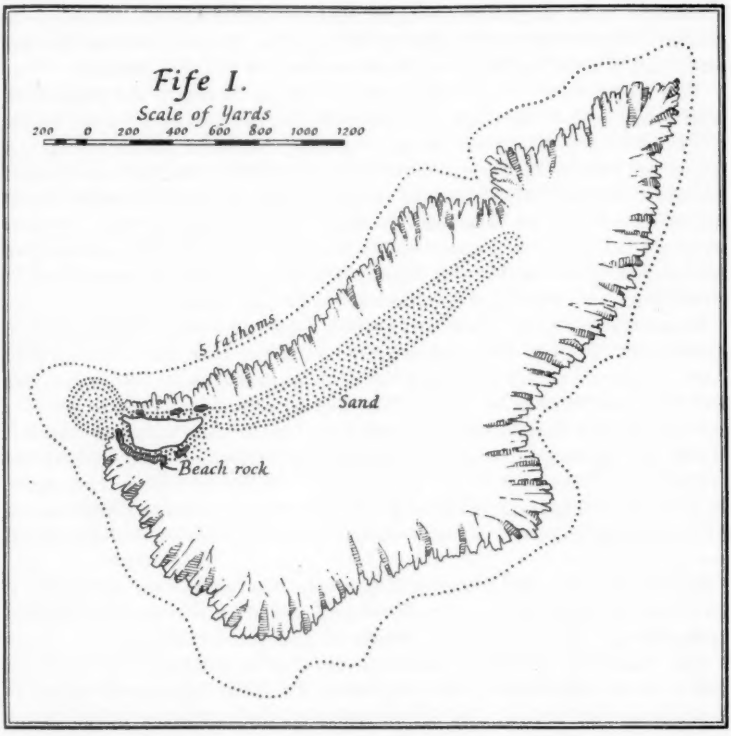
The actual occurrence of a cay is not therefore to be anticipated everywhere. Once the bank has emerged, so that dry land is produced, other factors come in. Birds will visit it; in this way seeds may be brought. Their droppings begin to produce slight changes in the soil. Seeds may also be carried to it by currents, wind, or people. Whatever the process, plant growth begins at some stage. The earliest plants are usually such genera as *Ipomoea* and *Sesuvium*. At first a few scattered plants arise, having practically no physiographical effect. If conditions are favourable, these plants gradually spread. Others, especially grasses, come in, and sooner or later a fairly thick mat of creeping plants and grasses is formed. From this stage onwards, stability is made possible. The plants hold and bind the sand, and once they have carpeted a large proportion of the surface, a storm will have to be powerful or prolonged to wash the cay away entirely. The waves may wash over the island and kill the plants, but this is not necessarily fatal, because the plants may still help the sand to withstand the attack, so that when normal conditions return the bank itself is still above ordinary high water. New seeds will soon come, and vegetation will gradually recolonize the island.

It is really only a matter of time and what may be termed seed-provenance before the cay establishes itself as an island with a vegetation of shrubs, and even trees, as well as the early creepers and grasses. Every possible stage can be found. On Sudbury Cay, for example, there was no vegetation at all in June 1936. It looked as if recently it had been awash in a storm. On this cay, as on most others, the sand is trailed out as a long, low spit, in this case running to the south-west. Wave incidence from another direction will remould such a spit, and so the direction in which a spit points is only evidence of conditions prevailing for a relatively short time before the visit is made. Similarly, the shape of cays is inconstant: they are rounded or oval in form as a general rule, but it is only their inner, vegetated, and highest parts that are at all stable in shape or position.

Undine Cay carried no vegetation in 1936. A later stage was seen at Mackay Cay. In 1928 this was covered, in its higher parts, with creeping plants and grasses. In 1936 there were just the beginnings of a new cover of plants. It is probable that the cyclone of 1934, which affected this part of the reefs, practically destroyed the cay. The cay on Arlington Reef, in 1936, showed a third stage. A strip roughly along the middle of the cay, about 8 feet above high-water mark, was covered with grass and creeping plants, and stood up rather abruptly above the rest of the cay. Michaelmas Cay is well known on account of its have been chosen as the site of the bore put down in 1926. It differs only in degree from Arlington Cay. There is a much larger central area, with grasses

[1] See also section 10.

and creeping plants, and it is the home of countless sea-fowl. Still later stages were seen in Morris Island and Fife Island. In the former there are bushes as well as creeping plants and grasses, and some sisal hemp, planted by some unknown person, gives it a distinctive appearance. Fife Island is more advanced: trees as well as bushes occur on it. Incidentally the reef on which it stands is, over large areas on its lee side, a mere sand-flat. Pelican Island is in much the same stage of development; its reef also is very sandy. Bushy Island, farther south, conforms to this same stage. It is a true sand cay, but



superficially resembles the Bunker and Capricorn Islands rather more than the more northern cays. As pointed out in 1929, the most elaborate cay is Green Island, off Cairns. It is larger than the others and rather differently situated, in that the reef on which it stands is more isolated and not just on the margin of the Barrier. The thick vegetation is noteworthy, especially the number of coconut palms which have been planted on it. They are not indigenous. As it forms a week-end resort for visitors, often in considerable numbers, it is not quite fair to compare its detailed development, and especially its vegetation, with the much more remote cays. It does however show to what degree stabilization and afforestation will reach.

So far no mention has been made of what is perhaps the most vital factor in the evolution of a cay—the formation of beach-rock. I stated in 1929 that I saw no cay on which there was beach-rock and an absence of vegetation. This statement holds good, but further investigation has shown that it must be treated with caution. The point is illustrated by Ellis Island. In 1936 we passed very close to this cay, but did not land on it. Careful inspection through field-glasses failed to show any trace of vegetation, but there certainly was a good deal of beach-rock. This apparent anomaly was explained by our pilot, Mr. Moynahan, who had frequently seen the island. He pointed out that there used to be vegetation on it, but that this was destroyed recently by a cyclone. I do not know of another strictly comparable case, but doubtless the same kind of thing has happened from time to time on other islands.

The formation of beach-rock therefore seems to follow the vegetation. There may be a direct connection between the two processes [1]; but on the other hand it may merely be that once vegetation has had a stabilizing effect on the island, the resulting lesser movement of the beach material results in its becoming lithified. The formation of beach-rock on these and other islands still needs explanation. The theories which have been put forward to explain its origin fail to give any complete account of its limitation to parts only of the beaches of an island in this region. The process of its formation may be satisfactorily explained; the incidence of the process is not.

However, once the rock has been formed, the island, even if not safe, is much more stable. Erosion can, and does, break up the rock, but completely to destroy a spread of this material a foot or more in thickness requires a severe and prolonged onslaught. Hence it is that islands, once they are partially surrounded by this rock, withstand storms far better than those unprotected. It may be suggested on more than reasonable grounds that if Ellis Island had not been so protected it would have reverted to the sand-bank stage again. As it is, it should not be long before it is re-covered by grasses and other plants. The stabilizing influence of beach-rock is also well shown on Sherrard Island (see section 9 (*g*)).

On the true cays no definite evidence was found of any recent change of level. The beach-rock may often stand high and show unmistakable signs of undercutting, but final evidence of such a movement is wanting.

The vegetation of all these islands is very similar, and generally resembles that of the Bunker and Capricorn groups. The following species were collected from Fife Island; they are all typical of the commoner plants on the northern cays, and may be regarded as early colonizers: *Abutilon* sp.; *Capparis lucida; Solanum viride; Scaevola frutescens; Josephina grandiflora; Tribulus cistoides; Canavalia obtusifolia; Polanisia viscosa; Euphorbia atoto; Spermacoce* sp.

5. The Lower Bench and Associated Features

This bench is awash at high water, and during storms and hurricanes would suffer some erosion. It is however argued in this paper that it represents an uplift of a few feet in recent times. This accords with general opinion amongst Australian physiographers, but there are some who are not convinced that a

[1] See Steers, 1929, *loc. cit.*, p. 249 and footnote thereon.

negative movement of sea-level need be appealed to in its formation. Hence it is necessary to analyse the evidence as fully as possible.

In the first place traces of it were found all along the Queensland coast, and also excellent developments of it were visited north and south of Sydney in New South Wales. That at Narrabeen was described in 1929. Several other localities were seen in 1936 between Bulli and Botany Bay. The connection between these more southern benches and those in the Barrier region is discussed later.[1]

The upper surface of the bench in northern waters usually shows no definite sign of present wave erosion. For more exposed localities this statement needs modification. The general weathering action of atmospheric agents together with that of spray leads to the disintegration of the surface, and consequently to lowering, but this is a separate factor and, in the writer's opinion, subsequent to the movement which brought the bench, as now seen, into existence. On the other hand, the outer edge of benches, no matter where they occur, gives clear evidence of active erosion. Large blocks are often torn off the edge and thrown up on to the surface. In the special type of platform [2] seen on coral islands the weathering of the outer edge gives extremely jagged and bizarre effects.

The bench occurs in all types of rocks and in a variety of structures. The comparatively horizontal bedding and relatively soft nature of the Triassics near Sydney show it to perfection, but steeply dipping phyllites as at Double Island, rhyolitic rocks as at Cockermouth Island, and the coral conglomerate platforms of the coral islands also show it very clearly.

Attention may be drawn to the fact that although it is awash at high-water springs, the number of hours in each tidal cycle that it is covered with water to a depth sufficient to allow active erosion at its inner edge is comparatively small. This statement implies a further point: where it is found there is always good evidence of former cliffing behind it. In exposed places, *e.g.* those facing the open ocean, these cliffs are still steep, but in more sheltered localities they have often weathered back to more gentle slopes.

The most significant point however is the occurrence of platforms in coral conglomerates on the low wooded islands at a level which is apparently directly comparable with that of the benches cut in solid rocks. In the absence of precise tidal data exact measurements are not available, but the fact that all these benches, or platforms, wherever found are awash at high-water springs is a sufficient criterion to establish their similarity, if not exact equality, in height. The coral island platforms are described elsewhere in detail, but a few general points should be noted here. Plants such as *Sesuvium* and trees such as *Avicennia* are common on them, but their occurrence may not definitely establish their raised nature. However taken in conjunction with all the other evidence they form a strong link in the argument. Trees are, at any rate, not likely to establish themselves if erosion is proceeding actively. This point, as well as the contention in general, is strongly supported by the fact that on some

[1] Detailed references to Narrabeen and other localities not mentioned here are given in my earlier paper, *loc. cit.*

[2] To prevent ambiguity, the word "bench" is used in this paper to denote an erosion feature in continental rocks. Platform is used for a similar feature on coral islands.

continental islands, *e.g.* Stephen's Island, the bench occurs on the leeward as well as the windward side.[1] When this is the case, the bench is often partially plant-covered on both sides. It is also common to find on the sand cay unit of the low wooded islands normal beach-rock at similar levels, and showing clear evidence of being severely eroded on its outer side: large blocks are torn off and cast up on to the surface of the platform. But the surface itself does not suggest that it is being extended by wave cutting to-day. In the first place *Sesuvium* and other plants often thrive on it and, secondly, all the available evidence points to the fact that what wearing down occurs is due to atmospheric agents together with a certain amount of pot-holing action due to waves during high tides and storms.[2] Naturally any such exposed surface will tend to be worn away, and one situated as this is particularly likely to show this process. But in many places where the field evidence was considered, there was no reason to think that present marine action was doing any more than cutting into the platforms and not constructing them. In fact, it may be stated conclusively that wherever this lower bench or platform occurs, no matter what may be the nature or structure of the rock, it is being destroyed. As far as our observations went, we noticed very little evidence that the sea had yet cut a ledge at a lower level. Such a ledge would hardly be expected on a coral island if the writer's contention of the nature of platform formation on such islands is correct (see section 8). But a lower ledge, very narrow, is occasionally seen a few feet (2–3 feet) below low-water mark, as on Treble Island in the Guardfish Cluster. All this points to the conclusion that the movement, whatever its nature may have been, which brought this lower bench into existence took place recently.

Apart from the existence of the bench or platform itself, there is also a good deal of collateral evidence of this recent uplift. Sometimes this is seen in the existence of reefs which are dead, owing to their having suffered a slight upward movement. The reef near Donovan Point was mentioned in my previous paper. In 1936 the reefs at Stone Island, Cockermouth Island, Enn (=N) Island, and Holbourne Island were also examined.[3] These reefs are dead on their upper surfaces. It is reasonable to ascribe their death to this same recent movement, but a too-sweeping assertion on this point is not justified. It may be asked why do not all reefs show this same phenomenon? [4] Hedley [5] pointed out that the Stone Island reef was largely killed by a heavy rain-storm coinciding with a very low tide. But, on the other hand, it is not unreasonable to suggest that Stone Island reef had already suffered an upward movement relative to sea-level before the storm, *i.e.* it was in a critical position. This same argument may also apply to Holbourne Reef, but Marshall, Richards, and Walkom [6] concluded that the combined evidence of several features (benches, old caves, dead reef, shingle ridges now out of reach of the waves and at a high level) on this island suggested uplift. Many reefs are also dead

[1] *Geogr. J.* 74 (1929) *op. cit.* The bench is also on both sides of Grimston Point on the mainland.

[2] Solution also probably plays a part.

[3] Section 8.

[4] See section 11 *re* depths of reefs.

[5] *Reps. Gt. Barrier Reef Committee*, vol. 1, 1925, p. 35.

[6] *Ibid.*, p. 29.

on their surfaces on account of their being almost completely sanded over. The flat between Ingram and Beanley Islands and the north-western part of Fife Reef are good examples. It is not necessary to assume all reefs should be killed by a movement such as that suggested here: it would presumably only seriously affect those which were already higher than normal, and so in an unstable condition.[1]

A more convincing point is the common occurrence of ridges of coarse shingle at heights, as well as situations, remote from present wave action but clearly related to this bench or platform. On King Island and Enn (=N) Island, to mention only two of several, such ridges were common, and to doubt their raised nature seemed absolutely unwarranted. When found they are usually well covered by plants and even trees. They are not by any means confined to low wooded islands. As already mentioned, they are found on Holbourne Island, and in a much more exposed locality, where there is no reef, an excellent example occurs, namely at Noosa Point, about 80 miles north of Brisbane. Here is a raised ridge of coarse shingle behind the present beach and at a higher level. Trees were growing on it, and adjacent to it was a typical example of the lower bench cut in metamorphosed sandstones dipping gently to the south-east (approximately). I had the advantage of discussing this and several other cases in the field with Queensland geologists, and our opinion as to the raised nature of the benches and beaches corresponded. As shown elsewhere, the lower bench is often accompanied by a higher one, both on continental and on coral islands. There are possible traces of this higher bench at Noosa Point.

It may be contended that these high shingle ridges are hurricane beaches. To do so seems to imply that the benches are also due to the same cause, as well as raised reefs and other features yet to be described. It also implies that hurricanes are commoner occurrences than is the case, because these features are found in well-developed states at least from Bulli to Cape Direction (about 2000 miles), and that during the comparatively short time during which they act they have been responsible for cutting benches on all sides of some islands and also for cutting benches many yards wide in rocks of all kinds of hardness.

A feature which must be considered in this same connection is the common occurrence of flats covered by mangroves and low sandy areas with *Casuarina* and other plants, which are found along the mainland coast and on some of the high islands. These have been described by other writers and ascribed to a recent negative movement.[2] The present writer is in full agreement with this view. Much the same kind of thing is found in the great sand-spits which now incorporate such places, formerly islands, as Capes Bedford and Flattery in the mainland coast. A traverse across the Cape Bedford peninsula made in June 1936 showed in the various sections which were found that the tombolo is a sand-flat, and such a flat is undoubtedly aided in its formation if a slight upward movement is postulated in the formerly shallow water between the original islands and the mainland.

The low bench also occurs in many sheltered localities. There is a good example of it at Sea Hill, inside the mouth of the Fitzroy River. Here the

[1] For a full discussion of other collateral evidence see *Geogr. J.* 74 (1929) *op. cit.*

[2] For a fuller discussion and detailed references see *Geogr. J.* 74 (1929) 343 *et seq.*

bench is sheltered from storms and recently a sand-spit has grown out in front of part of it. There are also traces in Rodd Harbour and Pancake Creek west of Bustard Head; in neither of these places can its formation be easily ascribed to present-day conditions. There may also be traces at Ugly Point in the Cook River estuary, south of Sydney. Very close to Bunnerong Power Station, inside Botany Bay, is another ledge, backed by cliffs, which is possibly part of this same bench.[1]

Taken separately, none of these observations may afford conclusive evidence, but collectively they point very strongly in favour of a recent slight upward movement of the land relative to the sea. The field evidence supports this contention. The conglomerate platforms on the low wooded islands are in a much more sheltered region than are the exposed benches of South Queensland and New South Wales. Yet all are awash at high water, and this is, at present, the only means of gauging their height. True, in some parts of the Queensland coast it is possible to use the rock oyster (*Ostrea mordax*) as a rough datum. As shown in 1929, the upper limit of this bivalve approximates to the level of high water of neap tides. Where it occurs on the outer parts of a bench it is usually seen to be a little below its average surface-level.

Hence, in the writer's view, there is no doubt that this is an upraised platform. At present one cannot be sure of the means by which it was raised. The similarity in level over such an extent of coastline points however to a eustatic movement of sea-level. Whether such a water oscillation is connected with the waxing and waning of the polar ice-caps is not definitely known. The significance of this view in connection with Spender's proposed grouping of island-reefs is discussed in section 12.

At what level, then, are platforms cut? This cannot be answered at all definitely, and this is not the place to discuss the evidence in detail. Jardine [2] analysed several of the Queensland benches, and concluded that the lower bench is not raised, but cut at present level. This is at variance with the views expressed in this paper. If open oceanic coasts alone are considered, a fair case can be made in favour of Jardine's views, but for the several reasons discussed above some modification seems necessary. Whilst granting great power to storm waves, especially at high water, it is reasonable to suppose that the zone of maximum cutting is below mean water-level. Here the waves are acting for a much longer time with considerable efficiency, and in stormy times there is not a great difference between their cutting power at any state of the tide. Furthermore, if this low platform is ascribed to present cutting during storms and high tides, it follows that the waves are concentrating most of their work on, and at, the *inner* edge of the benches, because it is presumably only in this way that the benches could be widened and the cliffs made to retreat with any speed. But the occurrence of rather graded and old cliffs and the clear nature of erosion of the *outer* edges of the benches do not seem in accordance with this view. The final point against the argument would be given if newer and lower benching were to be demonstrated in front of cliffs

[1] J. Beete Jukes, 'Voyage of the *Fly*,' 1847, vol. i, p. 336, also argues strongly and convincingly for the raised nature of certain coastal-flats. His arguments are based partly on the distribution of pumice pebbles. I too have seen and noted this phenomenon and am in general agreement with Jukes.

[2] *Reps. Gt. Barrier Reef Committee*, vol. 1, 1925, p. 111.

Treble Island. Upper bench

Hunter Island. Upper and lower benches

Stone Island. Old cliff line and storm beach

Holbourne Island. Dead reef

and existing benches. Unfortunately, I am unable to give convincing cases of this process in Australia, due partly, in all probability, to the comparatively recent movement which, while it has given rise to the bench,[1] has not left sufficient time to allow another to form in front. Further work may throw light on this matter. In the meantime, the writer's view is that benches are cut at or a few feet below mean sea-level on the stretch of coast here considered, and consequently that the existing fragments of the lower bench indicate an upward movement of the land relative to this level of about 8–12 feet as a maximum. I think 5 feet is a nearer estimate.

It will be convenient to describe a few cases where this lower bench and associated features are well seen. Stone Island near Bowen is small and formed of continental rocks. It is partly fringed by a raised reef and by high conglomerate platforms. It was examined with care by the writer, who was accompanied by Dr. W. H. Bryan. Reference to the map will make the following account clearer. Former cliffs, now out of reach of the sea and grassed over, follow long stretches of the shore. They are fronted by ridges of coarse shingle now overgrown with grasses and plants, and pass downwards to the present beach. To the west and south-west is a good example of a raised shingle spit, now prolonged into its modern counterpart. Much of the eastern side consists of raised beaches fronted by fragments of coral conglomerate platforms now being eroded by the sea. The rapid visit made to this island in 1928 led the writer to suggest it had been uplifted: the longer visit in 1936 left no doubt about the matter. The raised reef has been described by Hedley,[2] and will not be discussed here except to say that it is consistent with the features noted above. Holbourne Island, visited with Professor H. C. Richards and others, agrees with Stone Island very closely. Further details can be seen in the paper referred to in the footnote on p. 18.

Middle Island, described in some detail in 1929, was revisited and the views then expressed were confirmed. A more detailed examination of the raised features also led the writer to confirm Stanley's view that the upper conglomerate platform is *in situ*, and consequently that the island gives good evidence of a double vertical movement.

It would be tedious to describe other examples of this platform in any detail, but the following list names the localities, other than those mentioned above, where traces of this bench were visited and inspected in 1936: the north-western corner of South Keppell Island (cut in steeply dipping phyllites and greywackes); another example farther west on this same island, and in a more sheltered locality, where at one place the bench is 60–70 yards wide and is cut in similar rocks highly contorted, puckered, and overthrust—it is possible that traces of the higher bench also occur here; North Keppell Island: several traces were seen on the mainland and occasional islands between North Keppell and the Duke Islands, but were not actually visited; South Percy Island; Middle Percy Island; Scaw Fell Island; Grimston Point, both on leeward and windward sides; Fitzroy Island, where a good example of a raised beach occurs at 19 feet above low-water springs; Double Island and Haycock Island (also seen 1928); and Dunk Island, where the late Mr. Banfield's

[1] See *Geogr. J.* 74 (1929) 347.
[2] *Loc. cit.*

house, now the restaurant of the modern settlement, is built on the old cliff line corresponding to the raised platform. This list does not include many examples seen whilst passing close by numerous high islands on the return voyage from Townsville to Bundaberg.

6. Cliffing

The question of cliffing was discussed at some length in 1929. There is not much to add to what was then written, but a few points call for comment. A bench obviously implies a cliff, and consequently many of the cliffed areas in reef waters are to be regarded as raised cliffs, granting that the lower bench is raised. There are many undoubted cases illustrating this point, *e.g.* Stone Island. The same argument applies to all the instances given of the lower bench on p. 21. In Pearl Bay, between North Keppell Island and Cape Manifold, an interesting example was seen from the boat. A well-marked break in the hill-slopes occurs about 150–200 feet above sea-level, and from this point an old cliff falls steeply to just above the water, but it is not being attacked by waves to-day. In part the cliff seemed to be of ancient, and presumably indurated, dunes. The slope was clad in vegetation and the flat, or beach, in front was covered with *Casuarinas* and other strand-like plants. In two or three places there appeared to be outcrops of solid rock. Professor Richards and Dr. Bryan were on board at the time, and we agreed that it is an excellent example of an old cliff and that it probably corresponds with the lower bench.

The headlands along this strip of shore, as well as the islands, *e.g.* Dome Island, are cliffed much as one would expect headlands facing an open sea to be cliffed. A reasonable amount of cliffing was seen on the weather side of the Duke Islands, but on Marble Island, in the same group, another old cliff-line, now untouched by the waves, was seen on that part of it near Lola Montes Pass. This too I was able to discuss with Dr. Bryan. Some of the finest cliffs in the whole area must be those on the south-eastern part of South Percy Island; certainly they were the highest I have seen in this region. A moderate amount of cliffing was seen on the exposed parts of most of the Cumberland Islands, and Mr. Kemp noticed somewhat similar features on the weather side of the Palm Islands when I was away from the *Cambria*. On further inspection, the Cape Upstart cliffs proved perhaps not as conspicuous as was suggested in 1929.

Farther north, where the reefs are closer to the mainland, our observations agreed with those made in 1929. Hence on this matter no essential alterations need be made to my previous account. It may be stated, as far as cliffs are concerned, that there is nothing against the hypothesis of the reefs having protected the coast and islands, and that where reefs are few or absent, as in the southern part of the reef area, the degree of cliffing is consistent with a recent change of sea-level. It may perhaps be remarked that, where big cliffs are found, as on South Percy Island, it is reasonable to suppose that they are the direct descendants of those which were cut before a change of level took place. Any bench which may have existed in front of them has been eroded away, and now old and new cliffs are blended into one. They may be termed rejuvenated cliffs.

7. The Higher Bench and Platform

There are many traces of this higher bench on the mainland coast and continental islands; occasionally platforms of similar height are seen on low wooded islands. The average surface of the bench in solid rocks stands about 15–17 feet above low-water level. It is found in a variety of rocks and structures, and its remains are now suffering erosion. It is older than the lower platform, as is shown by the fact that where both are found together, the lower one is cut into the higher.

It will be convenient to describe some typical examples. On Treble Island, in the Guardfish Cluster, the platform is well developed in a complex structure including volcanic agglomerates intersected by dykes. The surface is relatively level and is 17 feet above low-water mark. It is also 6 feet above the general upper level of *Ostrea mordax*. Behind the platform the old cliffs are still clear and fresh. At the time at which the platform was formed this island would have consisted of three stacks. A good example is also seen on Flat Top Island (Mackay), where the average surface level is 16–17 feet above low-water mark. The bench is 16–20 paces wide and is backed by a pronounced cliff. Trees were growing on the inner edge of the bench. Traces were also found on the south-eastern side of Lindquist Island. The level here was about 22 feet above low-water mark. The shelf is cut in schistose rock, and accords closely with Hedley's observations in the neighbouring islands.[1] Other cases were described in 1929.[2]

A corresponding platform is also well seen in coral conglomerates. The best case, perhaps, is that on Hunter Island in the Duke Group.[3] Reference to the section will make the following description clearer. Above the present algal flat, the replica of the algal flats seen so frequently in the low wooded type of island, is a boulder zone which gives place to a scarp about 4 feet high. This scarp is the outer edge of the lower platform, which is made of coral conglomerate and which is partly covered by a cemented capping of large pebbles. Inwards, these pebbles give way to the ordinary surface of the platform. Inside this again is a nearly vertical and extremely jagged wall rising about 9 feet above the lower platform. *Casuarinas* were growing on the surface of this higher platform, behind which were sands and dunes. The upper platform was greatly eroded, large, pot-hole-like features reaching down from its surface to its base. In these were often found masses of pebbles cemented together. The corresponding feature, in shallow pot-holes, was seen on the present algal flat, although there the pebbles in the pot-holes were loose.

The spread of pebbles on the lower of the two platforms seems to have acted as a protective capping, and appears to be the remains of a former spread of coarse beach material which lay on parts of this old platform when it formed the reef flat. The material of which both platforms are composed was well bedded and showed the usual seaward dip of about 5°. Our visit to this island was made in the company of four Queensland geologists, and the general opinion expressed was that two distinct movements were involved.

[1] *Reps. Gt. Barrier Reef Committee*, vol. 1, 1925, p. 61.

[2] *Loc. cit.*, p. 345.

[3] For a general description—excluding the material touched on in this paper—of the Duke Islands, see a paper by L. C. Ball, *Geol. Surv. Queensland, Publication* 194, 1904.

Cockermouth Island presented some particularly interesting features. South-west from the main mass of the island (670 feet high) is a raised coral reef which embraces two or three smaller islands, so that at low water they form part of the main island. In one of these the lower bench is well developed in rhyolitic agglomerates, and in the other in Devonian tuffs. Between these islands and the main island are some relict patches of coral conglomerate. The patch marked A on the map shows two distinct levels. The heights given in the section are only rough estimates made by three people. Allowing for error however they show the approximate relations of these features and levels. The conglomerate material is worn into very bizarre forms, and the vegetation on the surface of A is approximately 29 feet above low-water mark. It is worth while remarking that in a natural hollow of A, pure quartz sand-rock was seen at a level of about 4 feet above low-water mark. All the higher material was calcareous. The combination of two distinct levels of coral conglomerate, the lower platform cut in two different kinds of rock, a raised coral reef, and a raised sand-spit make this island one of more than usual interest.

These, together with the instances seen in 1928 and those described by other writers, show that the higher platform extends over a wide area, but its remains are much rarer and more scattered than are those of the lower platform. It was suggested in 1929 that certain platforms of coral conglomerate on the low wooded type of islands are to be ascribed to this same level. Further work in 1936 established the occurrence of higher platforms in some of the low wooded islands, but a discrepancy should be noted. The remains of the higher bench in solid rock are about 15–17 feet above low-water mark. The higher platform in the low islands (*i.e.* excepting Hunter and Cockermouth Islands) never exceeds 11 feet (approximately) in the examples seen by the writer. Yet it is possible that both belong to the same movement. That coral conglomerate platforms can actually exceed the 15–17-foot level is seen in Cockermouth Island. There is no reason to think that all such remains of platforms and benches should be at the same height throughout the great length of the Queensland coast. It must also be remembered that the low wooded islands are in comparatively sheltered water. More precise work on the tidal range in various localities may also help to explain the discrepancy.

However the higher platforms of the low wooded types of island will be included in this section on the understanding that the writer fully realizes the discrepancy, and thinks that more detailed work extending over a long period will either explain it or show that a third and intermediate platform exists. It is also relevant to point out that it is no help to equate the higher platform of the low wooded islands to the lower bench in the mainland and high islands. Evidence has been given to show that the equation of the lower bench on mainland, continental, and coral islands is highly probable even if not established. A doubt which may remain to some physiographers is that it is a raised bench, as claimed in this paper. The evidence has been set out fairly, but the writer is alone responsible for the conclusions drawn, even if they do happen to coincide with those of several Australian physiographers with whom he has discussed the matter.

To return to the higher platform on the low wooded islands: the example of Three Isles was discussed in 1929, and for further details reference should

be made to Spender's [1] map. In 1936 the platform was seen to be well developed on Houghton Island, especially on the sand cay, where the surface of the beach-rock is 8–9 feet above the reef level and approximately 10–11 feet above low-water mark. In some places the sea, after covering the reef flat, is cutting a new platform in the upper conglomerate rock 6–7 feet below its surface. The excellent development of the lower platform on this island is intermediate in height between the two features just described. There are traces of the higher platform on Coquet Island. Enn (=N) Island affords a good example, the two platforms being juxtaposed in one place. The higher is approximately 3 feet above the lower where they meet. The latter would be awash at high-water springs; the former is generally well covered by vegetation and is well above tide-level except for spray in a storm. Where the higher platform reaches the shore, it stands 7–9 feet above the reef-flat, and so, as at Houghton Island, 10–12 feet above low water. At Enn Island it is undercut in places to 10 or 12 feet, leaving slabs only a few inches thick near their outer edge, but strong and hard and safe to walk on. Traces, not very convincing, of a platform 2–3 feet above the lower one were seen on Hay Island. These may belong to the higher platform.

It appears, then, that the higher platform has a restricted development on the low wooded islands. It may yet be found on islands north of Cape Direction, but there is good reason to think that most cases south of this point have been examined. There is no obvious explanation for its present restricted development. If however it should be definitely established that it can be correlated with the higher bench of the mainland coast and continental islands, it will be somewhat easier to explain. Assuming for the moment that it does so, it seems that we have reasonable grounds for postulating a double movement of the land relative to sea-level. There is every reason to think that the higher platform is a good deal older than the lower one, and for this reason one can hardly expect a great number of traces to remain on what are, in a geological sense, somewhat transitory islands. It would help very much if traces of the corresponding bench were found along the coast of the Cape York Peninsula.

8. The Formation of the Lower Platform on the Low Wooded Type of Islands

The general nature of this platform on the low wooded islands has been described. As it is such an important feature, its origin must be discussed at some length. The thesis outlined here is that the platform derives originally from a rampart or shingle ridge.

There are several arguments in support of this view. One of the characteristic features of a platform is that it is usually a narrow ledge, 10–20 yards broad, sometimes more, but narrow as compared with its length. Platforms are almost entirely confined to the windward side of the islands on which they are found; they are nearly always discontinuous, although in some cases, *e.g.* Beanley Island, their discontinuities are perhaps only due to subsequent erosion. In other cases there is no need to assume that the several parts of a platform were once continuous. In ground-plan they closely resemble the

[1] *Loc. cit.*, folding-plate No. 2.

flattish outer ramparts which are so common on this type of island. Both features occur on the windward sides of islands, and nearly always there is to be seen not only a platform but also a well-developed outer rampart. The rampart is a wave-built structure; its particular form is largely the result of the material of which it is made. The occurrence of the platform in the same environment suggests that it is in some way related to wave-action; certainly it is now undergoing destruction by the waves.

Another point in which they are directly comparable in general appearance is in their smoothness of summit level, the platform being usually rather higher than the rampart. Neither a rampart nor a platform is quite level, *i.e.* apart from the minor and numerous irregularities of detail. In cross-section they are also similar. The outer ramparts slope gently down to the seaward side of the reef from often a wide and flat summit. The lee slope is steep, practically at the angle of rest of the material forming the rampart. As this material is very finger-like and often branched, the lee slopes occasionally approach the perpendicular. The lee side of the platform is often obscured by mangroves, but natural sections can easily be found. Thus in superficial appearance they have much in common. The two main differences are (1) that the rampart consists of loose material; and (2) that the outer, seaward, edge of the platform is nearly always an erosion edge and is very jagged. If erosion has gone on to a considerable extent it may have eaten into the platform so that only the practically level upper part remains, thus diverting attention from the original gently inclined seaward face.

Of greater significance is the fact that both features are made up of the same kind of material. The shingle fragments can easily be seen in the rampart, but if the surface of the platform is more or less intact, its inner structure is not too clear. However a glance at the outer eroded edge and any natural hollows on the surface will show that the material is the same. Many platforms have been eroded to a considerable extent, one effect of which is the production of basset edges, generally on the outer and lower part of the platform surface. Where seen, these edges nearly always show an inward dip, their general appearance being not unlike a ploughed field seen from a point at right-angles to the direction of the furrows, so that one is looking at the "scarp" slope of the upturned sods. But this inward dip closely resembles the steep inner slope of the outer ramparts. The degree of dip is comparable, and in general the fragments in the basset edges lie exactly like the fragments of shingle on the back-slope of a rampart. A rampart owes its shape to an over-rolling action of the waves, the steep back-slope being due to material pushed up over the gently sloping face and falling down on the lee side. This too strongly suggests a like origin for the two features.

Both platform and rampart rest on the reef flat, and even if no true platform occurs, basset edges are often seen on the slightly higher parts of the present reef flat inside the outer ramparts. The dip of the basset edges is almost always inwards, but a seaward dip, only very local, was noticed on King Island. If the contention that the platform is a cemented, ancient, and presumably raised rampart is made, it is easy to explain these occasional variations in dip, because it is not unusual in new ramparts to find one joining or partly over-riding another, and where they come into contact the ramparts may be

bent inwards. If such a part were lithified and eroded, basset edges dipping in several directions would be formed. In similar ways minor unconformities can be explained.

The most conclusive argument of their common origin however was found on Burkitt Island. Here the platform is seen to break down, in its outer part, to basset edges, and the slope and cross-section of the whole feature is directly comparable with that of a broad rampart. The basset edges begin as slight depressions in the platform, and run approximately parallel to its length. In one place the platform was about 50 yards wide and its outer edge but little eroded. Careful observation along the outer edge showed that there was a clear transition from the smooth lower slope, through basset edges, to the normal eroded front of an ordinary platform.

This particular instance and the reasons given above render the like origin of rampart and platform a reasonable hypothesis. But a point remains. If this is the case, need the platform be raised? Platforms are only awash at high water and, *e.g.* on Two Isles, there seemed to be no difference in level between rather low present-day ramparts and traces of older platforms. This and others are doubtful cases, but where the platform is well developed relative movement appears to be necessary to explain the facts. The inside position of the platform with respect to the rampart seems to support this view. The writer did not find evidence in favour of Spender's suggestion of a cycle of events so that after a given interval a new rampart grows when the older one has been pushed some distance inwards. The almost constant relative positions of rampart and platform on so many islands, so widely scattered, suggests a more uniform cause than a cyclical scheme, which might be applicable to an individual island, but not to so many as to produce virtually the same effects. Furthermore on those islands of the low-wooded type where the sand cay also shows high beach-rock, there is nothing on the cay which supports the view that the rampart of the shingle island was formed at the same level as the platform either on the shingle island or the sand cay. If there is newer beach-rock beneath the old on the sand cay, it only helps the hypothesis of a recent negative movement of sea-level. I agree with Spender in most of his remarks concerning ramparts and basset edges, but he refers mainly to Low Isles,[1] Hope Isles, and Three Isles. It is not easy to understand why there should usually be such a marked development of an outer rampart as distinct from an inner rampart and/or platform, and I admit that the idea of a recent negative movement of sea-level presents difficulties. It has however been shown that a great deal of evidence all points to such a conclusion, and if such a movement has taken place, all the reefs should be similarly affected.[2] I suggest that the sanded nature of many reef surfaces, the dead appearance of many others, as well as the occurrence of sand cays on the inner reefs support the views tentatively put forward in this paper. Definite proof of minor fluctuations of sea-level in the reef area will probably be found only in an extension of the shallow bores first attempted at Low Islands in 1929.

[1] Low Isles: the name is applied to the sand cay and the mangroves, but as both form a unit comparable to all other low wooded islands, the singular is used. The same applies to Three Isles and Two Isles.

[2] See also sections 8, 11, 12.

One further point may be noted. If occasional ramparts are higher than the associated platforms, it does not necessarily negative the opinions already expressed. A modern rampart is occasionally subjected to powerful wave-action and can still be piled up. If the supply of material is considerable and the waves big enough, there is no reason why parts of a rampart should not exceed the platform in height. The platform behind the rampart is protected to no small extent from direct wave-action; the material of which it is made has had time to settle and the surface is usually suffering some slight amount of weathering. All these reasons help to make it lower than it was when it was still a rampart. Further, a slight upward movement of the reef with respect to sea-level would presumably expose a part of the reef in front of the platform. This would be the natural place for a new rampart to form. It may be remarked here that in many islands we saw a strip, often 20 or more yards wide, in front of the present outer rampart, and thus comparable to that between the outer rampart and the platform or inner rampart.

If the view that platforms originated as ramparts be accepted, there is no need to demonstrate that remnants of raised flats should be found in sheltered places on the reefs. All the reefs will have been raised, and the frequent deadness or sanded nature of so much of their upper surfaces finds, perhaps, an easier solution in this way. It may also follow from this that the mangrove swamps are *post* this last oscillation. Before such a movement took place the reef might have been rather too far below the surface for the trees to establish themselves. So far as I know no work has been done on this aspect of the matter, but the general appearance of the present mangrove swamps does not suggest any great age. That not all inside reefs show the same development need not be taken as a negative argument. Travelling amongst the reefs, and careful inspection of the charts, will soon demonstrate that even to-day the reefs are far from reaching the same general level. Some are uncovered at half-tide, others at low water, others again soon after high water. Still others are always submerged. Exact equality of surface height is not the rule to-day, and there is no reason why it should have been in the past.

(*To be continued*)

THE PRE-COLUMBIAN DISCOVERY OF AMERICA

JAIME CORTESÃO

I PROPOSE to confine myself to the discussion of some new documents and to show their importance in order to arrive at a solution of the problem of the pre-Columbian discovery of America, in connection with the voyages of Christopher Columbus. I omit all references to the Norse discovery of America, which I consider a historic fact, as well as to the hypothesis of the discovery by the Mandingo negroes, studied by the American historian Leo Wiener, and by the Basques, which has also been frequently discussed by French and Spanish historians, and intend to deal only with the hypothesis of the pre-Columbian discovery of America by the Portuguese. I say the hypothesis, but it is convenient to add that it has become a historic fact for the majority of Portuguese historians and many foreigners, of whom I will quote only Prestage, Zechlin, Biggar, Babcock, and Oliveira Lima, who at least accept it as very probable. For my part I have endeavoured, in successive works, to establish a method for the study of the problem.[1]

In my opinion, although I have to consider new sources, it was not owing to the lack of documents, but to want of method in their study, that some events of the past have remained obscure. The problem with which I deal becomes much clearer when we study it in the light of the two following considerations: the geographical environment systematically connecting the facts with the circumstances in which they have been produced; secondly, the preponderant role played by economic factors in the evolution of the knowledge of the Earth. This allows us to establish a new scale of values for the whole of the known texts and documents. Two errors have obscured this chapter in the history of geography: (1) the supposition that trans-oceanic voyages were more difficult than those along the coasts; (2) the neglect of the consideration that the economic objectives, pursued by the State, might prevent the divulgation of geographical discoveries from reasons of high policy. When we study the three Atlantic continents together, from the point of view of the duration of the voyages between them, we reach the conclusion that, in a general manner, America is rather nearer Europe than is West Africa. A sailing ship takes the same time to come from Newfoundland to the English Channel as from the Straits of Gibraltar; and the same time from Cape Horn, the farthest point of South America, to the Channel, as from Lagos, in the Gulf of Guinea. A glance at the map is enough to make us realize the big difference between these several distances. With regard to the voyages from Europe to America or Africa, the disparity, though less noticeable, remains.[2] Furthermore the crossing from one continent to another, making use of the north-east trade winds and the equatorial stream

[1] Jaime Cortesão, "Do sigilo nacional sôbre os descobrimentos," in *Lusitania*, No. 1, Janeiro 1924; "Le traité de Tordesillas et la découverte de l'Amérique," in *Atti del XXII Congresso internazionale degli americanisti*, Roma, Settembre 1926, Istituto Cristoforo Colombo, 1928, Vol. II; 'Los descubrimientos precolombinos de los portugueses,' Barcelona, Salvat Editores (in the press).

[2] See the time charts of the voyages of the sailing ships on the Atlantic, in Gerhard Schott, 'Geographie des atlantischen Ozeans,' Hamburg, 1926, pp. 308–309.

from the north—which in the sixteenth century the Spaniards called the Ladies' Gulf—was as nothing compared with the voyage from Europe to the Gulf of Guinea or to the Cape of Good Hope, in which the zone of the equatorial calms or that of the storms in the South Atlantic had to be crossed.

Another error is to suppose that all the truth about the geographical discoveries of the Portuguese must be found in their official chroniclers; this is what an eminent Italian historian, Carlo Errera, treating of this subject, called "The insuperable argument of the silence." But we must remember that the Portuguese monarchs of the fifteenth and sixteenth centuries were merchant-kings, who pursued economic objectives through their navigations —that is, to establish commerce in tropical products, mainly those of the Orient, in order to become the intermediaries between the countries of production and Europe.

It has been forgotten that all nations which have discovered new routes towards countries of rich products and secured their commerce, have sought to act as follows: to transform the trade into a monopoly; to close the routes by means of treaties and prohibitory fables, or by persecution of all transgressors; to conceal their policies and commercial activities, as well as the facts connected with them; to keep an eye on foreigners abroad and at home and to exclude them from their social circle. This was typical of the Carthaginians, who having discovered the countries producing tin, a product indispensable to the industries of that time, concealed the routes leading to the Cassiterides, closed the Straits of Gibraltar, and prohibited access thither by the most cunning and ruthless means; it was so with the Hanseatic League of the Middle Ages; and the Dutch in more modern times. This policy of monopoly and secrecy was the stricter in proportion to the weakness of their defensive means, the number of potential competitors, and the extent of the maritime routes and of the newly discovered lands. Portugal, a country of a very limited population during the fifteenth century—it had no more than 1,200,000 inhabitants—which had discovered immense and very rich lands, of which she had seen a part invaded and ravaged during the war of the Succession to the Spanish throne (1475–1479), was a typical State fitted to be the organizer of the "Mare Clausum" and the monopoly of trade beyond the seas. The gold and the spices which the Portuguese looked for so eagerly were not less coveted in Europe than tin at the time of the Carthaginians, and their role as intermediaries also required monopoly and secrecy.

Prince Henry the Navigator began by organizing in 1443 the monopoly of the trade and navigation of the newly discovered lands. In 1454 the Pope ratified this monopoly, forbidding all Christians to navigate towards the discovered lands without permission of the king of Portugal. Other prohibitive decrees followed, and, in 1480, the king ordered that the crews of foreign ships found in the Portuguese zone of navigation should be thrown into the sea.[1]

Thus it is necessary to consider the policy of secrecy of the Portuguese princes, and other means of concealing from foreigners the knowledge of the sea routes towards the new countries. Having analysed the context of the

[1] See 'Alguns documentos do Archivo Nacional da Torre do Tombo,' Lisboa, 1892, pp. 9, 14, and 45.

Portuguese chronicles I have arrived at the following conclusions: The *Chronicle of Guinea*, of Zurara, the existence of which was discovered only in the last century, from the copy in the Bibliothèque Nationale at Paris, is a résumé of a previous chronicle only, and has been truncated and mutilated in those passages which could better enlighten foreigners on the intentions of Prince Henry, or the commercial geography of the newly discovered lands and perhaps other unknown objectives. Thus, for instance, Zurara quotes the chapters of his work, where he referred to the division of the Oriental countries, in connection with the reasons which impelled him to undertake the discoveries. All these chapters have disappeared from the chronicles. On the other hand, a series of chronicles of Fernão Lopes, Cerveira, and Zurara, which is known to have existed formerly, and which might contain the history of the discoveries, has also disappeared. One of the official chroniclers, Ruy de Pina, has summarized these chronicles and it is clear that he suppressed some information about the discoveries which were recorded there. Finally in the chronicles of Ruy de Pina these voyages of discovery towards the west are not mentioned, although to-day we have no doubt about such voyages. However, this is not astonishing, because in the chronicle of King John II there is no word about such important events as the voyage of Bartholomew Dias, during which he doubled the Cape of Good Hope, or the voyage of Pero da Covilhã to Calicut and from there to Sofala, which together contain the secret of the true sea route to the Indies. Taking these facts together, one may conclude that policy treated these discoveries as a State secret and forbade mention of them.

As a last proof, I have already recalled the following forgotten fact: in the *Côrtes* of 1481, that is to say in the first year of the reign of King John II, the people asked him in future to forbid foreigners to settle in his Kingdoms and dominions, pointing out that the Genoese and the Florentines became too dangerous because they revealed his secrets of the Mina and the Atlantic Islands.[1] It was no longer a political plan of the rulers alone: the whole nation demanded severe measures for maintaining the secret of the discovered lands. The documents were sequestered; to record new lands on the maps was forbidden; the nautical works became secret books; prohibitory tales were spread; and the navigators forced to keep the oath of silence. This is why João de Barros, historian of the discoveries of the time of Afonso V, after mentioning the coasts and islands of Africa discovered, adds: "other trades and islands have been discovered, of which we will not speak in particular, because we do not know when and by which captains they have been discovered. However everybody knows that at the time of this king many more things happened and were discovered than we have written . . ."[2]

The argument of silence cannot therefore be invoked about the Portuguese chroniclers. Official historians were silent, either from ignorance or for reason of State, about many facts connected with the secret policy of the nation. Once these two fundamental points are established—that America, as regards the voyages of sailing vessels, was nearer to Europe than was West Africa; and

[1] Visconde de Santarém, 'Memória para a história e teoria das côrtes gerais,' parte 11, pp. 219 *et seq.*

[2] 'Decadas da Asia,' I, livro II, cap. II.

that the Portuguese chroniclers hid or ignored many of the principal facts of the history of the navigations—we may proceed to examine the sources in which we can find indications of the concealed voyages.

The following supposition seems reasonable. Since Christopher Columbus lived for some years in Portugal, where he matured his projects, we might expect to find in his notes some information about the voyages of the Portuguese towards the West, if such voyages had been made. Unfortunately many of his notes are known only through the transcription of his son Ferdinand in the 'Historie della vite e dei fatti di Cristoforo Colombo,' and it is known that he endeavoured to hide or to distort all that could diminish his father's glory. Even so, we find plenty of rather conclusive evidence in the 'Historie' of Ferdinand Columbus, the 'Historia de las Indias' of Las Casas, and the ship's journal of Columbus' third voyage.

In his 'Histoire critique de la grande entreprise de Christophe Colomb,' H. Vignaud had already called attention to some of these notes, and the fact that during his sojourn at the monastery of la Rabida, the navigator had spoken with some sailors from Palos, a village near the convent. "Columbus himself," writes Vignaud, "reports that a pilot called Pedro de Velasco who dwelt in Palos told him, at the convent of Santa Maria de la Rabida, that with a certain Diego Detiene he had navigated 150 leagues towards the south-west of the island of Fayal (one of the Azores) seeking for the island of the Seven Cities, and that, as they did not find any land on that side, they came back and after discovering the island of Flores, they continued towards the north-east where they made some observations which led them to think that there existed some land to the West." [1] In his notes Columbus dated this voyage from 1452. From Portuguese documents we know that this Diego de Tiene, that is to say Diogo de Teive, a navigator in the service of Prince Henry, had discovered the Island of Flores by that time, and that at the end of the same year the Prince granted him the monopoly of the sugar production in the Island of Madeira—which might represent the reward for very important services.

In a study about this voyage I have rectified an error of the text, which says: "they continued their way towards the north-east till they had Cape Clear, in Ireland, to the west." This wording is absurd. In the first place it is impossible, when going towards the north-east, to find the Antilia or Island of the Seven Cities, which, according to the same F. Columbus, was placed by the Portuguese navigators to the west of the Azores. On the other hand, sailing from Fayal towards the north-east, that is to say towards Cape Clear, it was impossible to discover lands to the east of this cape, in latitudes perfectly known to mariners. The same Ferdinand Columbus, when identifying the land whose existence had been suspected with the land of the Bacalhaus, or Newfoundland, understood that the voyage had been done towards the north-west. So there is no doubt about this point. Columbus had registered in his notes the double voyage of Diogo de Teive towards the south-west, adding that at the end of the latter the navigator had found signs of land. Besides, the chronicler Herrera, in the beginning of the seventeenth century, in his 'Decadas,' had already given the correct version. The correction of this error in the text of F. Columbus and of Las Casas has a considerable

[1] Tome I, pp. 72–73.

importance, and the interest of this part of the notes of Columbus has remained unnoticed by all historians.

Having thus corrected the text, let us analyse the signs of land found by the navigators. "In these latitudes (when Cape Clear was to the west)"—writes F. Columbus—"they met with very strong west-winds, but the sea was quiet, which they thought to be caused by some land remaining westwards. But it was already the month of August and, fearing the winter, they did not dare to continue their voyage." But on the whole coast of North America there is one point, and only one—the Newfoundland bank, near the Avalon Peninsula —where the strong west winds (in this region prevailing in August) could coincide with a quiet sea and signs of a coming winter, out of sight of land.

This coincidence between the text and the immutable circumstances of physical geography lends a great value to this testimony of Columbus. But there is more. It is known that after the death of Columbus, his heir, Diego Columbus, unable to obtain from the king the entire recognition of his rights, requested permission, which was given, to assert his claim before the courts of justice. During the long suit, the king's attorney-general and the Pinzon family intervened, claiming at least a part of the discoveries ascribed to Columbus as belonging to Martin Alonso Pinzon. Some of the oldest inhabitants of Palos, the village where the fleet of Columbus had been equipped, instead of confirming the role ascribed to Pinzon, declared that there was in Palos, when Columbus was dealing with the project of his enterprise, a man, Pero Vazques de la Frontera, very learned in maritime questions, who in former times had made a voyage towards the west in the service of the Prince of Portugal, and had given important information to the famous navigator. Three of the witnesses agreed in this statement. But the principal of them, Fernando Valiente, declared: "What he knows is that Don Christopher Columbus, before going to negotiate the discovery with the Catholic Kings, came to the borough of Palos seeking for support and help in order to go to the said discovery, and he lodged at the monastery of la Rabida, and from there he came sometimes to the borough of Palos and spoke with one Pero Vazques de la Frontera, who had gone once for making the said discovery with the Prince of Portugal, and that this Pero Vazques de la Frontera gave advice to the said Columbus and to Martin Alonso Pinzon, and encouraged the people, and told them all in public to go on this voyage, because they would find a very rich land, and the witness knows that because he saw the said Columbus and heard what he reports from the said Pero Vazques de la Frontera, and he said that at that time in the public places; and the witness has seen that the said Columbus and the said Martin Alonso Pinzon went speaking and negotiating both together, and he saw that Columbus departed, and they said that he went to the Court to negotiate with the Catholic sovereigns." [1]

Since a Spanish historian, Fernandes Duro, published some extracts from these depositions, Vignaud was the first to call attention to the importance of these testimonies, although making this concession: "As the depositions to which we owe all these informations have been collected with the object

[1] See the Spanish text in Jaime Cortesão, "A viagem de Diogo de Teive e Pero Vasquez de la Frontera ao Banco da Terra Nova em 1452," in *Arquivo histórico da marinha*, I, Lisboa, 1933.

of showing that the part of Columbus in the discoveries that he made was not as great as his son Diego pretended, it is possible that some of those who gave evidence in this way were badly disposed towards the admiral and had exaggerated matters somewhat." [1] As Vignaud had known only the partial extracts of Duro and, in order to form an exact idea, it was necessary to study the process in its ensemble, I have examined the manuscript of the 'Pleitos,' at the Archivo de Indias in Seville, and I have verified, with surprise, that the depositions, the extracts from which as given by Duro contained many errors, were much more important than was imagined. All this part of the process aimed, with evident injustice, to diminish as much as possible the role of Columbus as the initiator and realizer of the enterprise, in order to ascribe it to Martin Alonso Pinzon. From this point of view, the testimony on the advice of Vazques de la Frontera to Columbus contradicted indeed the object of the examination, which was to exalt Pinzon to the detriment of Columbus; and it did not agree with the hostility which separated the Spaniards from the Portuguese, especially the sailors living in the frontier. But a reading of these three witnesses' depositions leads one to accept their relative honesty, especially that of Fernando Valiente, the most objective and clearest of the three.

To all the many searching questions he kept obstinately saying that he did not know anything of the subject. In short, his deposition absolutely frustrated the object of the inquiry, and this, contrary to what Vignaud believed, adds importance to his testimony on the voyage of Pero Vazques with the Portuguese. The note of Columbus on Pedro de Velasco and the depositions of the inhabitants of Palos agree in many points: the two pilots lived in Palos at the same time; they had both sailed in the service of the Prince of Portugal, that is to say of Prince Henry the Navigator; they had given very interesting information to Columbus on this voyage towards the West; and both were convinced of the existence of lands beyond the Azores. Obviously struck by this fact, Vignaud added this comment, when speaking of Pero Vazques: "It is possible that this individual is the same as the Pedro Velasco from whom Columbus admitted that he had received some information. But in this case, he did not reveal the true nature of this information and the importance that he attached to it." [2]

I believe that I have found the explanation of this duality of name. We know that Christopher Columbus and his brother used to write in Latin, including the names of persons. For instance, in one of the best-known marginal notes in the books of Columbus, the name of the Portuguese navigator Bartholomew Dias is latinized as Bartholomeus Didacus.[3] Besides, Velascus was the usual latinization of Vazques. When Ferdinand Columbus found in the notes of his father the name of Velascus, he translated it as Velasco, more usual in Spanish, the more so since one of the richest merchants of Seville at that time was called Pedro de Velasco. I have also found in the text of F. Columbus and of Las Casas some traces of a primitive Latin version.[4]

[1] 'Histoire critique de la grande entreprise de Christophe Colomb,' Paris, 1911, II, p. 25.

[2] *Ibid.*, pp. 22–23.

[3] *Raccolta di documenti*, Parte I, liv. III, Serie C, no. 23.

[4] See Jaime Cortesão, *loc. cit.*

Consequently I believe that Pedro Velasco and Pero Vazques are one and the same person. Finally, in my opinion, two considerations render the hypothesis of the duality untenable: that Columbus having received such important information from two pilots, at the same time and at the same place, only noted down that of the former; and that each of the three witnesses who deposed in the process only quoted the latter.

While researching in the Portuguese archives and those of Seville, I could not find any Velasco, but at Seville I discovered some documents referring to a Pero Vazques, navigator, servant of the queen of Castile, but to whom the king of Portugal, in 1471, granted the rights of citizen of Lisbon, as reward for his services.[1]

The identification of Velasco and Vazques, strengthening the testimony on the subject, permits us to consider the voyage of Teive as a historical fact, and the physical circumstances referred to in Columbus' description—very strong west winds with the sea quiet, and the winter earliness, at a point situated north-west of Fayal and west of Cape Clear—give great probability to the conclusion of Columbus, that is to say that Teive had been very near Newfoundland. We must notice that the declination of the magnetic needle, always very pronounced in these parts but unknown at that time, caused confusion between a west-north-west and north-west rhumb.

In my opinion the real importance of these documents and conclusions is to establish a more solid base for the study of the subsequent documents on the voyages towards the West, in search of that land which was called the Island of the Seven Cities. Indeed the same notes of Columbus contained information on other attempts of the Portuguese to reach that land, which Ferdinand Columbus identified always as Newfoundland. Unfortunately when Ferdinand reports the attempt of Fernão Dulmo and promises to relate it, he passes from one subject to another without keeping his promise. Notwithstanding, we know a series of documents, chiefly of Portuguese origin, either on the voyage of Dulmo or about other attempts of exploration, all aiming at the same objective.

In 1475 the king of Portugal, by two successive letters-patent, granted to Ferdinand Teles, officer of the court, and of the royal Council, permission to send his ships to search for the Island of the Seven Cities; he also granted him the monopoly of commerce in this land, and in the same document the king ratified the purchase of the Island of Flores, which Teles had just obtained from the son of Diogo de Teive.[2] This fact and the objective of the Seven Cities clearly established the connection between this and the former attempt. The works of Storm, Nansen, and Larsen showed that at this time an expedition had been sent to the northern seas to search for islands and a continent, under the auspices of the king of Portugal.[3] The Danish historian Larsen asserted that this expedition explored Greenland—which seems to me proved—and also the north-east of North America, as far as the Gulf of St. Lawrence,

[1] Archivo municipal de Sevilla, appendice à la seccion 1a *Cartas Regias*, carpeta 1a, no. 3.

[2] 'Alguns documentos,' pp. 38 *et seq.*

[3] Sofus Larsen, 'The discovery of North America,' London, 1925; Nansen (F.), 'In northern mists,' London, 1911; Storm (G.), "Johannes Scolvus," in *Norsk hist. Tidsskr*, 2 ser. 5 vol.

which in my opinion is rather doubtful. But it seems that the objective of this expedition was the same as of the former attempts.

In 1486 people still dreamed of searching for the Island of the Seven Cities, as appears from the better-known project of Fernão d'Ulmo and João Afonso do Estreito, "les précurseurs immédiats du grand génois," as Vignaud says. The eminent historian of Columbus, who did not know Portuguese well enough, could not discern the sense of the documents connected with this project. I cannot examine them here as well as I should like, but I will not pass without noticing that the letter-patent with the authorization of King John II states that the two navigators intended to reach "a large island, or a firm land (that is to say, a continent) according to the extension of the coast, which was presumed to be the Island of the Seven Cities." [1] We must observe that in this sentence the fantasy of the Island of the Seven Cities is in the second place. What is claimed is the knowledge of a vast country, although geographically hardly determined, which is quite natural; and what is presumed is that this country is the Island of the Seven Cities. One might say that an attempt had been made to adapt a reality to a legend. If it was the contrary they would not say a large island, some islands, or a firm land, because in every previous map the Island of the Seven Cities was always represented as a single island. I must add that the navigators were to sail from the Azores; that they hoped to reach those lands within at most forty days; and that they intended to set sail in April. But from January till mid-April the navigation off the coasts of Newfoundland is interrupted by ice-floes, and it becomes dangerous about the middle of August. Thus the moment chosen for the departure was the best for the proposed lengthy exploration.

But of this project we know no more than the letters-patent, and we cannot affirm that it was carried out. I will add only that the Portuguese historian, Bensaude, the author of 'L'Astronomie nautique des Portugais à l'époque des grandes découvertes,' inferred from the documents which we have been analysing that at this time, in 1486, the existence of a continent west of the Azores was already known.[2]

Though we do not know the results of Dulmo's project, many historians, like Biggar, agree in admitting to-day that after the beginning of 1492 and during three years, Pero de Barcelos and João Fernandes Labrador, under secret instructions of King John II, explored the north-east coasts of North America.[3] I will also add that Cabot, probably informed by Labrador, on his return from his first voyage proclaimed also that he had just discovered the Island of the Seven Cities.[4] We can then conclude that after a certain date the Island of the Seven Cities had been identified with a part of North America, probably Newfoundland. In view of the existence of the famous map prior to the return of Columbus from his first voyage, ascribed by Charles de la Roncière to the great navigator, we can ask: if Columbus was truly informed about the existence of a land towards the west by this Pero Vazques

[1] 'Alguns documentos,' pp. 58 *et seq.*

[2] 'Lacunes et surprises de l'histoire des découvertes maritimes,' Coimbra, 1930, p. 297.

[3] *Revue hispanique*, tome X, p. 295.

[4] *Cf.* Harrisse, 'Jean et Sebastian Cabot,' p. 323.

and other navigators, like Dulmo, and if the map was his, may not this land be marked there? In fact, to the north-west or rather to the north-north-west of the Azores, but any way in the same position where Newfoundland was represented in the Cantino map of 1502, we see a group of three islands with the following inscription (translated from the Latin): "Here is the Island of the Seven Cities, now a colony of the Portuguese, according to the Spanish mariners. People assert that we find here silver in the sand." [1] It is still the Island of the Seven Cities as well as a Portuguese colony, information that the cartographer obtained from the Spaniards, and very rich, as reported by Pero Vazques; and although the inscription refers only to one island, the map shows a group of three islands, which is also in opposition to the tradition and the anterior cartography, but agreeing with the wording of the Dulmo's letter-patent. In other words: nomenclature, geographical position, legendary economic characteristics, Portuguese sovereignty, but Spanish information, everything agrees with the pre-Columbian sources.

The historian of geography, Charles de la Roncière, who moreover did not know all the documents that I have quoted here, after having studied this inscription on the Island of the Seven Cities, did not hesitate to write: "It is at the very place of the Island of the Seven Cities of the Columbian map, that another Italian, Alberto Cantino, represented in 1502 a wooded island, discovered by Corte Real and named by him 'Terra del Rey de Portugall': it was nothing else but Newfoundland. The map of Columbus reveals to us in this manner the secret of the discovery of Newfoundland by the Portuguese." [2]

The striking accord between such different sources and testimonies affords a mutual confirmation. And if the pre-Columbian discovery of Newfoundland, as a kind of "Island of the Seven Cities," reported by Columbus in his notes, becomes more probable, the localization of this land, its name, and the respective inscription bring undeniable support in favour of the opinion of Charles de la Roncière, whether we consider the map drawn by Columbus himself, or by some one of his acquaintance.

But we do not find here the simple accord of testimonies on a common fact alone; we find also what is important: the accord of successive facts which linked together explain each other reciprocally. In 1452 the navigators Teive and Vazques, after having discovered the Island of Flores, continued their voyage and observed signs of the existence of a land to the north-west of the Azores; in 1475 Teles bought some of the islands discovered during this voyage and purposed to search for that land, that is to say, the Island of the Seven Cities, which they supposed to be peopled, and to trade there; at the same time an exploration of Greenland is made in search of "terra firme" on this side; in 1486 people speak already of the existence of a "large island, some islands or firm land, according to the extension of the coast," that is to say, a great country; they propose to arrive there, sailing from the Azores in April, within forty days at most; and, in 1492, there is a map which places this land in a fairly correct position, if we consider the means then at their disposal for the calculation of longitudes [3]; and at the same time the navigators Barcelos

[1] Ch. de la Roncière, 'La carte de Christophe Colomb,' Paris, 1924, p. 27.
[2] *Ibid.*
[3] See Nansen (F.), 'In northern mists,' t. II, p. 270.

and Labrador by the order of the king explored in the same direction, which, according to a document of 1508, had as a result the discovery of the northern continent.

These are not the only testimonies which we owe to Columbus. During his third voyage the great navigator relieved the Island of S. Tiago, at that moment the most important of the Cape Verde archipelago. He related in his log-book that the people of the island told him that King John II had a "great inclination" to send his ships to discover towards the south-west of the archipelago.[1] The king died in 1495, and this "great inclination," according to the expression of Columbus himself, which suggests that there had been many other previous expeditions, dates this enterprise at a time prior to the first voyage of the navigator. The testimony of the notables of S. Tiago had great authority, because living in a place which was practically a forced port of call for all ships which were bound for the Equatorial Atlantic they were well placed to collect information about the direction of these expeditions.

The testimony of Columbus is more explicit. This is what he wrote in his journal during his stay at S. Tiago, according to Las Casas: "The admiral says that he wants to go towards the south [let us add that he went in the direction of south-west] . . . because he wants to know on what king John II of Portugal's opinion was founded, *who declared that there was a continent towards the south*. And on account of that the Portuguese king had a quarrel with the kings of Castile, which ended by a removal of the line of partition to a position 370 leagues west of the archipelago of Cape Verde, and Columbus adds that the said king of Portugal was certain of finding within his limits famous lands. . . ." [2]

To sum up: The king was convinced of the existence of a continent towards the south-west, on account of which he had refused the Pope's partition by a line 100 leagues to the west of the archipelago; his refusal led to the treaty of Tordesillas, which set back the line of partition 270 leagues; the king was convinced that it included an important part of this continent. In fact, south-westward of the islands of Cape Verde lies Brazil, of which a large part was included in this division. Was this alteration the result of prophetical intuition, wise foresight, or bold audacious cosmographical reasoning? The explanations which have been advanced seem rather weak to justify the strong refusal of the king to the partition made by the Pope, and his persistent efforts which led to the treaty of Tordesillas. And only "the argument of the silence" can explain the incredible inattention of historians to so important a testimony coming from such an authority.

Further, after a long interval other evidence confirming that of Columbus has become known. For instance, we know a letter written in 1500, just at the moment in which Cabral arrived at Brazil, by a Spanish cosmographer who was on board the fleet, which contains a strange disclosure. Master John, the cosmographer in question, writes to the king informing him about his calculations of latitude for the position of the new land. But, as it was more difficult to calculate the longitude, he adds: "In what concerns the

[1] Fr. Bartolome de Las Casas, 'Historia de las Indias,' Cap. 131.
[2] *Ibid.*, Cap. 132.

situation of this land, please command that they bring to you the world-map of Pedro Vaz Bisagudo, and Your Highness will be able to see on it the position of this land. Notwithstanding this map does not declare whether this land is inhabited or not. It is an old world-map, but the Mina is registered there." [1] The owner of this world-map, Pero Vaz Bisagudo, was a navigator rather well known in the history of Portugal. Though this map was old, as the Mina had been discovered in 1471, it might be a little later than this date. Some have even connected with the declaration of Master John the map of Andrea Bianco of 1448, where we see the contour of a vast land south-westwards of Cape Verde, with an inscription saying that it extends 1500 miles towards the west. An English historian, Yule Oldhan, and others later, claim that it was Brazil.[2] For my part I do not believe that the two documents are sufficiently connected to offer a basis for study, and thus I omit it from my exposition.

But there are other documents much more important and agreeing with Columbus' testimony. The first is a letter, supposed to be of Estevão Frois, written to king Manuel in 1514. When in 1513 this navigator returned from the coast of Brazil he was constrained to land at the Antilles, where the Spaniards imprisoned all the crew of the ship suspecting that they had invaded their domains. In his letter Frois, or Flores, the factor of the caravel, wrote to the king asking for his protection, and telling him that all the Portuguese, after having been interrogated and some of them tortured, declared that they came from a land of the king of Portugal situated 150 leagues to the south of the Equator, and that for more than twenty years this land had been in the possession of Portugal.[3] As they made this declaration in 1513, then the sailors of the caravel affirmed that at the moment when the Antilles were discovered, Portugal already knew and possessed Brazil. During my researches in the Archivo de Indias, in Seville, I found scores of unpublished documents about this long process, the transfer of the prisoners to Spain, their examination, the intervention of the king of Portugal, and their release after four years of suffering. These documents are very interesting for many reasons. But their interest in the present case is that they clarify for us the declarations of the Portuguese navigators. They all affirmed that they came from lands near the Cape of St. Augustine. That is the precise point of Brazil which they asserted to be in possession of Portugal since approximately 1492.[4]

A few years ago a Portuguese historian, Jordão de Freitas, discovered another document which agrees in a striking manner with the others already quoted. In 1531 a French ship, the *Pélerine*, belonging to the Baron de Saint Blancard, attacked the Portuguese factory of Pernambuco, in Brazil, situated very near the Cape of St. Augustine, and seized the small fortress which defended it. After leaving a garrison at Pernambuco, and loaded with products

[1] 'Alguns documentos,' p. 122.

[2] *Geogr. J.* 5 (1895) 221–239; J. Batalha Reis, *ibid.*, 1897, 185–210.

[3] See 'História da colonização portuguesa do Brasil,' published under the direction of Carlos Malheiro Dias, Porto, 1921, Introdução, p. xvli.

[4] I am publishing these documents in 'Descubrimiento y conquista del Brasil,' Barcelona, Salvat Editores (in the press). One of the most important was already published by Fernandez Duro, "La situacion del Cabo de San Agustin el año de 1515," in *Boletin de la Sociedad Geográfica de Madrid*, 1884, pp. 22–30.

of the country, the *Pélerine* returned to Marseille. Off Malaga a Portuguese fleet took the ship, the sailors and the cargo. The Baron de Saint Blancard lodged a complaint with the king of France. A mixed Franco-Portuguese tribunal sitting at Bayonne was appointed to try this and similar cases. Jordão de Freitas found some of the papers of the process of the *Pélerine*, principally the depositions of the Portuguese witnesses. Four Portuguese navigators declared that when the French attacked Pernambuco the Portuguese had there already a factory and dwelling-houses for more than forty years.[1] What is striking in this document is the accord between these declarations and the previous ones on the essential fact: the occupation of a land in Brazil; its situation near the Cape of St. Augustine; and the date to which they connect the fact, nearly the same. It can be objected that such declarations made to a tribunal are suspicious. But we cannot see what reason could lead the Portuguese to date so far back the occupation of that land; moreover in the complaint of the Baron de Saint Blancard the validity of the treaty of Tordesillas, ratified by the Pope in 1506, was not contested. The English historian E. Prestage and others have drawn attention to a letter of an English merchant, Robert Thorne, written from Seville in 1527 to the king of England, where he explains the negotiations of the treaty of Tordesillas, as had been done by Columbus; that is to say, that when it was signed, in 1494, the Portuguese already knew the existence of a southern continent to the west of Africa, and King John II wanted to include it in his limits. And he adds that by that time the Portuguese proclaimed it, saying that they were already in possession of Brazil before this date.[2]

There is a collection of documents of which the least we can say is that they are rather impressive. They agree on the general facts and in the details and, I dare to say, they explain each other. But it may be objected that, if the Portuguese knew the existence of Brazil before Columbus, why did they not clearly vindicate this fact at the moment of the negotiations of Tordesillas? At first, although they did not proclaim it, during the negotiations it was perfectly understood in Spain that the Portuguese ambassadors defended the possession of a continent in the South Atlantic, to the west of Africa. This is what appears from a letter of the Catholic sovereigns, written 5 September 1493 and addressed to Columbus himself, and from another letter of the Catalan cosmographer Jaime Ferrer to the Catholic sovereigns.[3] Secondly, we can assert to-day that the interest of the king of Portugal was, in addition to defending the possession of an austral continent, to conceal from the Catholic sovereigns the true situation and extent of these lands, and he behaved accordingly.

The fundamental aims of the Catholic sovereigns and King John II of Portugal were the same, to reach the Indies, the true East Indies, whence came the richest goods of the cosmopolitan trade. Columbus had convinced the Catholic sovereigns that Cuba was the country of the Indies, that is to say, that it was situated off the eastern coasts of Asia. In these circumstances,

[1] "A fortaleza e a feitoria de Pernambuco," in *Lusitania*, Lisboa, 1926.

[2] Thorne's letter has been published in 'Divers voyages touching the discovery of America,' Hakluyt Society, London, 1850, pp. 45–47.

[3] Navarrete, 'Coleccion de viages,' t. II, pp. 124 *et seq.*

to reveal to them a secret which might lead to suspicion of the existence of a continent or, at least, lands very different from the Indies, between Europe and Asia, was surely to endanger the national plan of the Portuguese, who had for so long sought the maritime route of the Indies round the Cape of Good Hope. The efforts of King John II will not be understood unless we admit that he wanted to conceal from the Catholic sovereigns the true aim of his navigations. This is the thesis of Bensaude and of another Portuguese historian, Duarte Leite. In their opinion, the importance attached by John II to the negotiations misled Spain; they ended by believing in the would-be route of the Indies discovered by Columbus.

If this could be proved it would explain also the reason that led the Portuguese king to defend the widening of his sovereignty towards the west, but to conceal always the exact situation of the lands which he coveted. I have found this proof. A document has been recently published in Spain, in a collection, without establishing its date and importance, which throws much light on the political aims of the Portuguese monarch during the negotiations of Tordesillas. At the moment, in 1499, of the return of Gama from his voyage to Calicut, when the true importance of the enterprise was realized in Spain, the first movement in the Court was of surprise and indignation against the king of Portugal. They said that they had been deluded. A memorial was even composed about the rights of the Catholic sovereigns to the possession of the Indies, to serve as a basis for a claim against the king of Portugal. This is the document which I have studied.[1] It was written probably in the very year of the arrival of Gama, or at the latest in the beginning of 1500; at least before Cabral set sail for his voyage. Here are in short the allegations: During the negotiations of the treaty the king of Portugal had never asked more than to extend his sovereignty in the Atlantic, because he wanted to discover other lands in this ocean, and because he considered himself prejudiced by the Pope's award. Accordingly, the Spanish sovereigns "as the lands of the king of Portugal remained closed and they wanted space for sending their ships to discover," accepted the division of the Atlantic "by a line which passed through the middle, keeping for themselves the half as far as the lands discovered by Columbus, which were *the end of the Orient and of the Indies*." In these conditions, and I continue transcribing from the document, "it was really a cheat to send to discover the Indies by an indirect door and entrance." In other words, the king of Portugal had already gone beyond their limits, "sending also ships towards west and north, that is to say, towards north-west, as far as Scitia" (Northern Asia).

The memorial ended by declaring that the Catholic sovereigns were no longer bound to respect the treaty. We can sum up then that until the last moment the real bearing of the treaty of Tordesillas was not realized in Spain, that it reserved to Portugal the route of the Indies round the Cape of Good Hope. In this document there is as yet no allusion to the discovery of Brazil, but it quotes, which is of the greatest importance, the voyages towards the north-west, before those of the Corte-Real, seeking for, if I may say so, the passage of north-east through the north-west. This fact constitutes a last

[1] 'Colección general de documentos relativos a las Islas Filipinas,' A. V., 1923, pp. 217–226.

proof that at this date the existence of a septentrional continent lying between Europe and Asia was known in Portugal.

I do not presume to bring this article to an end with the definite conclusion that America was discovered by the Portuguese before Columbus. In cases such as this, we must make a judicious study of documents and facts in order to see how far they help to explain the course of history. But it will be admitted that in the face of all the documents known to-day—and I have cited only the most important—an attempt should be made to reach the point where we can pass from hypothesis to the scientific fact.

But, even if we admit the authenticity of the pre-Columbian discovery of America, it might after all be said that, since this pre-Columbian discovery was kept secret, it has had no influence on history, which need not take it in account.

I do not think this is absolutely true. The facts or, if you will, the documents which I have just quoted are of the utmost importance in enabling us to understand the causes which led to Columbus' enterprise; they shed light on the origin of the Portuguese influence on the history of civilization; and they bring before us, with perfect clarity, the real factors that shape the course of history, the eternal springs of human life, stronger even than the love of resounding glory.

THE SAIDMARREH LANDSLIP, SOUTH-WEST IRAN

J. V. HARRISON AND N. L. FALCON

ABOUT four hours by car from the Dizful railhead on the main road from the Persian Gulf to the interior of Iran, the traveller suddenly enters a curious jumble of enormous blocks which may arouse his interest and perhaps tax his ingenuity to explain. From Dizful to the police post at Tang-i-Fani, the scenery calls for no special comment from the seasoned traveller in the Zagros Mountains. The journey at first has been through rather broken foothills, then it has been along the bottom of a wide sweeping valley, whose U-shaped cross-section suggests a comparison with a glacially-gouged one. The presence of a considerable but still wholly inadequate stream, the Saidmarreh River, incongruous to the vast valley it occupies, emphasizes the similarity, but there the likeness ceases, for whereas the glacial valley is cut through mountains independent of their build, here the U-shape is entirely produced by the large-scale simple wave-like folds into which the rocks have been thrown, one hard sheet nearly 1000 feet thick controlling the shape of the valley. The trough forms the floor whilst the walls are provided by the flanks of the two rock waves. That on the south-west builds the great mountain range of Kabir Kuh, which divides Luristan into the two natural sections of Pish-i-Kuh (in front of the mountain) and Pusht-i-Kuh (behind the mountain), and that on the north forms a range with a number of names, the part near Tang-i-Fani being known as Kuh Dufarush.

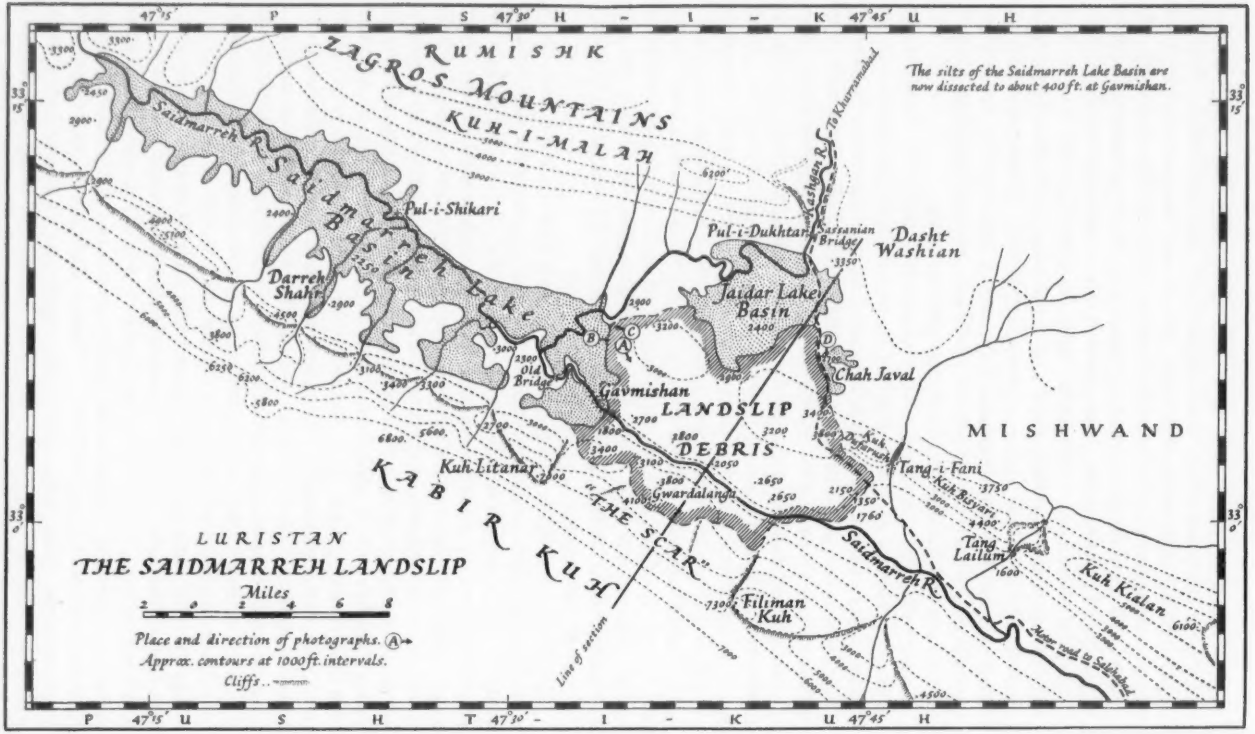
It is near here that the widely and thickly strewn blocks make their appear-

ance, occurring as a sheet from side to side of the valley, here nearly 3 miles wide. From the point where the road enters it zig-zags its way, climbing steeply, keeping close to the edge of the collection of blocks and not far from the steep slabs forming the smooth southern walls of Kuh Dufarush. In about 3 miles it climbs nearly 2000 feet before gaining the summit, still amidst the jumble of great angular rocks, some of which are large enough to have allowed the building of watch towers upon individual pieces. Several such erections were needed in days gone by, as the rough ground offered admirable opportunities to robbers wishing to ambush travellers. The same wilderness of huge angular boulders continues for nearly 3 miles beyond the summit across the axis of Dufarush and to the north over normal low rolling country. Then it ends and the ordinary landscape prevails again.

We have followed this apron of litter around its margin and found that its periphery measures 43 miles, and that its area is 64 square miles, and we estimate that its volume amounts to between 4 and 5 cubic miles. The surface of the detritus fan, as we have seen, is far from flat. From south to north it first falls to the river and rises beyond where the road climbs 1800 feet upon it, to a summit and then upon the northern side it falls 1400 feet before the re-appearance of normal ground. Besides this general curvature of the sheet, minor irregularities are very marked which take the form of secondary troughs and ridges traversing the boulder-littered surface from west-north-west to east-south-east. Within some of these a chain of ponds is now to be found, and in others, standing at a higher altitude, the trough bottom is smooth silt, the site of a drained pond. Still higher the troughs are less impressive, but a series of cock-pit hollows occur, the sumps which collect the run-off and then lose it gradually by seepage.

The Saidmarreh River which has already been encountered farther down the valley cuts right across the apron of debris not far from the south-south-west edge. The gorge is now fully 400 feet deep in parts, and the thickness of the rubbish nearby approaches 1000 feet. The steep walls of the gorge display the constitution of the debris better than elsewhere, as they are freer of the rain wash which has obscured things to some extent in most places. Great angular blocks of rock are embedded in a jumble of fragments from the size of dust upwards, it is, in fact, a loose breccia of large pieces associated with smaller ones grading down to the finest rock-flour. On the south of the river there are some huge rock masses within which the unbroken rock remains visibly stratified, but these are enveloped by a pulverized zone, and have obviously slipped down towards the river. On the north side blocks are seldom more than 30 feet long, broad or deep, but such blocks are still present in the most north-easterly tongue, 6 miles away from the river.

The detritus sheet over-rides and completely obscures the north-western nose of Kuh Dufarush, of which the simple arch-like section is intact where it is last seen near Tang-i-Fani. On the south side of the valley the regular outer mountain wall of Kabir Kuh suddenly ends in a line of cliffs running downwards from the jagged tooth of Filiman Kuh which stands 7300 feet above sea-level. Nine miles away to the north-west, the normal outer rock wall of the valley again appears bounded by another cliff rising up to the peak of Kuh Litanar, about 7000 feet high. There is thus a scar 9 miles long


47°15' PISH-I-KUH 47°30' 47°45'
33° 15'
33° 0'
RUMISHK
ZAGROS MOUNTAINS
KUH-I-MALAH
The silts of the Saidmarreh Lake Basin are now dissected to about 400 ft. at Gavmishan.
Saidmarreh R.
Saidmarreh Basin
Saidmarreh Lake
Pul-i-Shikari
Darreh Shahr
Old Bridge
Washian R.
To Khorramabad
Pul-i-Dukhtar
Sasanian Bridge
Dasht Washian
Jaidar Lake Basin
Chah Javal
Gavmishan
LANDSLIP
DEBRIS
MISHWAND
Kuh Litanar
KABIR KUH
"THE SCAR"
Gwardalangu
Kuh Barvari
Tang-i-Fani
Tang Lailum
Saidmarreh R.
Kuh Kialan
Filiman Kuh
Line of section
Motor road to Salehabad
LURISTAN
THE SAIDMARREH LANDSLIP
Miles
2 0 2 4 6 8
Place and direction of photographs. A
Approx. contours at 1000 ft. intervals.
Cliffs
PUSHT-I-KUH 47°15' 47°30' 47°45'

from cliff to cliff and from the cavity rock between 1000 and 1500 feet thick has been removed over a width of about 2½ miles, a body of material, amounting, as stated above, to about 5 cubic miles or nearly 30 cubic kilometres. The rock once filled up this scar in which its layers sloped towards the river at about 1 in 3 to the horizontal. Some catastrophe—presumably an earthquake—occurred and set in motion this colossal mass of rock which, in slipping off, smashed itself into fragments of all sizes from rock flour to these blocks as big as houses. These are now found in profusion up to 10 miles away from where they once lay in situ.

They can only have been carried there by their own momentum. It is hard to believe that this has been great enough to slide the debris so far, to spread out the great apron of detritus in the valley, and to take part of it up and over the end of the mountain range standing in its path 2000 feet above the base of the valley. At the same time the preservation of the large cuboidal masses of rocks to the very end of the detritus apron after this amount of travel can only be explained by their carriage upon a protecting raft of rubbish as it moved across the valley and hill to its present situation by a process of solifluction. We have often enjoyed that primitive entertainment of setting large boulders rolling down a steep hillside and have observed that they invariably break up in the process if they are of large size. Consequently we cannot picture the gigantic blocks bounding down the hillside individually and rolling on to their present situation, but that in the rush of the whole sheet they were protected from destructive impacts and indeed preserved from excessive friction which would rapidly have rounded their corners.

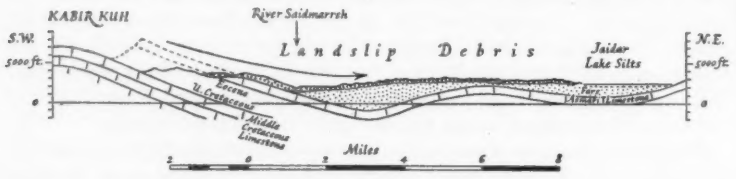
The obstruction thus placed across the country by the landslide dammed the Saidmarreh and Kashgan rivers as well as blocking up some minor drainage channels and held up lakes which eventually filled up with silt and were subsequently drained. Chah Javal is a small sheet of water, with an area of about half a square mile, which was trapped between the north-eastern lobe of the landslide material and rolls in the valley floor on the north flank of Kuh Dufarush. This has partly silted up to a height of 2700 feet above sea-level, but is still a lake, in part having lost its water by seepage.

Jaidar Lake had an area of about 16 square miles and the top of the silt deposits in it are now at 2400 feet above sea-level. It was caused by the damming of the Kashgan River where it emerged from the gorge through the hills at Pul-i-Dukhtar, where the ruins of the well-known great Sassanian bridge stand. Before the fall took place, the Kashgan probably pursued its general south-south-westerly course to join the Saidmarreh River near Gwardalanga at about 1800 feet above sea-level. In its journey it probably cut a notch through the end of the Kuh-i-Dufarush range, in the manner that rivers treat so many of the ranges in the Zagros Mountains. The fallen material filled the old valley up completely to such a level that the water of the lake rose and then escaped north-westwards over a depression in a lateral ridge in the Saidmarreh Valley under Kuh-i-Malah, thus entering one of the pre-landslide subsidiary run-off channels from this mountain to the main valley. It cut a gorge through the solid rock of the spur and so passed right round the north-westerly extension of the landslide into the Saidmarreh Lake.

This sheet of water gathered in the main nearly straight valley until it was

25 miles long and had a maximum breadth of 7 miles, its area being about 80 square miles. The height at which the water overflowed from this lake was about 2250 feet above sea-level, and it found an outlet channel by running across the landslip debris along one of the subsidiary troughs which have been described as crossing it parallel to its major dimension. The escaping water cut rapidly across the detritus, producing a nearly straight channel, without any meandering. In the meantime the old valley behind the dam had silted up and the river waters from the Saidmarreh River in the west and the Kashgan River in the north had to make new channels for themselves. This they did by meandering across the mud flats of the basin, upon which they joined and together made for the western end of the gorge cut across the dam. In the course of time the meanders of both rivers were entrenched to the extent of about 400 feet at the Gavmishan end of the lake and of not more than 100 feet at the upper end.

Probably owing to the extensive flat ground in reasonable proximity to the ample water supplies from Kabir Kuh, this district became well populated. A small town was built at Darreh Shahr in Sassanian or earlier times and below the town a bridge was thrown across the Saidmarreh River. Since then how-



Section of the Saidmarreh landslip

ever, a further bowing of a meander of the river has caused its bed to migrate nearly a quarter of a mile. This bridge, Pul-i-Shikari, is now high and dry on the left bank. At Gavmishan, 11 miles down stream, another bridge was built of similar architecture to that at Pul-i-Dukhtar. This structure was erected upon solid rock foundations in a gorge which was in almost the same state of erosion two thousand years ago as it is now. The piers are still well preserved, but the arches have fallen in.

These ruins suffice to show that changes in the scenery effected by the landslide had already been brought almost to their present state two thousand years ago and therefore we can say that the catastrophe took place in pre-historic times. On the other hand, geologically the event is a recent one, as the state of the pre-landslide valley shows.

Landslides in south-western Iran have been fairly numerous, although no other example appears to have occurred of anything approaching this one for size. Several mountains in Kuhgalu have a sheet of debris over a circumscribed area at their base, while on the flank a tell-tale notch displays where a mass of the mountain side had become detached and fallen off in exactly the same way as at Saidmarreh. Kuh-i-Nir and Kuh-i-Siah, both in Kuhgalu, are cases in point.

A landslide from the north-east dip slopes of Kuh-i-Dina in which the

Gwardalanga gap and Filiman Kuh from the north-west edge of the landslip (*A*)

The landslip debris (*B*)

Kashgan River gorge with landslip on left and Saidmarreh lake-beds in middle distance (C)

Kuh Dufarush, with Kabir Kuh in distance ; landslip debris on right (D)

debris was kept within a restricted valley to form a tongue-like mass 1½ miles long, occurred in 1933. It is exactly the same type but accidental configuration of the lower hill slopes led to an unusual distribution of the fallen material.

Other landslips in the same region have occurred by masses falling off the face of steep cliffs. Thus the south-western face of Kuh-i-Dina is perpetually experiencing small rock falls. When these have taken place on a grander scale the effects upon the scenery may be semi-permanent. Several are known in Bakhtiari country. One of considerable antiquity happened on the southern side of Kuh-i-Ushtarinan, a magnificent mountain, 14,000 feet high, when a mass fell off its southern cliffs into the valley about 6000 feet below, blocking the drainage and damming up the largest of the lakes in these mountains, Galleh Gahr of the tribal people, called Lake Irene by Colonel H. A. Sawyer. During the Great War, probably in 1917 according to the tribal people, another landslide occurred from these cliffs. This scar looked very fresh in 1931 when we saw it. A second smaller lake is impounded up-stream by this slide.

Some years ago H. G. Busk described another small landslide near Shimbar also in Bakhtiari Country (*Geol. Magazine*, lxiii, pp. 355–9, 1926).

The immense dimensions of the Saidmarreh landslip make it of interest to compare it with the pre-historic Ice-Age Flims landslip which is the biggest known in the Alps and with the Pamir example of 18 February 1911, which is the largest one which has occurred in recent times. In the notice given of the Pamir landslip in *Nature*, the volume was stated to be a little more than half a cubic mile, the fall of the centre of gravity 2380 feet, and the farthest distance any of the debris travelled was nearly 3 miles and its width nearly 3½ miles. In 1925 the lake which had formed was a foot deep and still rising. In the case of the Flims example, about 3 cubic miles of rock fell away, its centre of gravity moving through about 3000 feet while the tongue of debris stretched outwards to a maximum distance of 9½ miles and had an area of somewhat more than 15 square miles. Our Luristan slide measures between 4 and 5 cubic miles, its centre of gravity fell through 2800, the maximum distance travelled by debris was 11 miles, and its area 64 square miles. So far as is known therefore, the Saidmarreh landslip is possibly the largest one recorded in the eastern hemisphere.

Note on place-names

The Authors have taken care to obtain names from the local people, with the assistance of an interpreter. The local people are not consistent: one man may say Filiman Kuh, another Kuh-i-Filiman, and yet another Kuh Filiman.

THE CRATER OF NYAMLAGIRA: from the account of a journey by car from Mount Elgon through Malakisi, Jinja, Kampala, and Kabale, by

I. MITFORD-BARBERTON, A.R.C.A.

FROM Kanaba Gap we made a long, winding descent on to the lava-strewn plain and arrived at the Uganda Customs barrier at Kisolo. A few miles beyond was the actual Uganda–Congo frontier with a notice advising us to drive on the right-hand side of the road. At the Belgian Customs barrier there were only native askaris, and we took one with us up to the District Commissioner's office in Rutchuru, where we reported ourselves and asked permission to enter the Congo and climb the volcano Nyamlagira. The official told us that there would be no objection and that the arrangements would have to be made with Col. Hoyer, who was the Curator of the Parc National Albert in which this mountain stood. Col. Hoyer lived a few hundred yards away, and with him we arranged for a gang of five porters to meet us in the Parc the following afternoon. He told us that Nyamlagira was very active, and that the lava which had formerly been several hundred feet lower, had been rising at the rate of 3 metres a month for two years, and at this rate an eruption was expected in 1936. The inclusive fees for this ascent came to 63 shillings (421 francs), which we paid and then drove down 50 miles through the Parc and camped on the shores of lake Kivu in the township of Goma.

We walked about 3 miles down to the town of Kisenye the next morning. It was beautifully situated on the shore of the lake, but the depression seems to have killed it, and many of the houses were deserted. In the afternoon we drove back 25 miles, found our porters, and leaving one man in charge of the car, which we drove a few hundred yards off the road, we distributed the loads of bedding and food and commenced the ascent. It was rough going for the path was strewn with jagged lumps of lava. A few miles farther on we got into dense forest. The natives appeared scared, and told us in a whisper that there were elephants about and that they were *kali sana:* very fierce. Fresh elephant tracks were to be seen everywhere; we were quite unarmed; there were no suitable trees to climb should sufficient encouragement be forthcoming, and the country was so rough that it would be impossible to run more than a few yards off the path. Suddenly a great crash was heard in the bush about 30 yards from the road. Our hearts missed a couple of beats, and although we had already done about 16 miles we became perfectly fresh in an instant, and shot off the mark like greyhounds. Another elephant scare occurred about a mile or so farther on, when the front men saw an elephant cross the path about 50 yards ahead of us.

We slept that night in a little wooden shack built by Col. Hoyer. The light from the volcano could be seen clearly, although we were still 20 miles distant. We made an early start the next morning, marching through dense forest most of the way. We were not troubled again by the elephants, although we saw traces of them everywhere. The summit of the mountain is a black dome of old lava, and except for a few withered blades of grass, is devoid of vege-

Floor of the old crater

Distant view of Nyamlagira

Floor of the old crater

Cracked lava in the crater

tation, while beyond the rim rose immense columns of smoke into the sky. As we got nearer we could hear the roar of the crater. It sounded like a stormy sea.

The crater is about 2 miles in diameter and 300 feet deep, and on the northern side there is an opening through which we passed. There are actually two craters, the active one, which is about $1\frac{1}{2}$ mile across, lies within the older crater, and was a few years ago several hundred feet deeper, but the lava has now risen to within 100 feet of the surface. The floor of the old crater is split up with numerous cracks, steam is shooting out in many places, and near where we camped there is a group of sulphur jets which send a white barrage of asphyxiating fumes across the view. The ground here is very treacherous and we walked continually with a stick, feeling for hidden cracks before advancing. Looking into the active crater one sees a seething turmoil of steam, flame, and smoke. There must have been at least 600 acres of lava, twisted and distorted and split up with numerous cracks. The molten lava oozes up through these cracks, flowing in a thick red stream over the surface. Protruding above the lava bed, on the southern side, stood a group of five small cones or chimneys, which shot up huge columns of blue and white smoke and occasional bursts of flame. They were about 20 feet high and 100 feet across, and from our higher view-point we could see the red molten lava boiling inside. Spasmodic bursts of flame shot up from below with a loud roar, throwing the red lava high into the air. Around the black sides of these cones lay acres of yellow sulphur which had condensed from the fumes. We were unable to get close to these chimneys, as they were cut off by the perpendicular wall of the crater on one side and acres of hot lava on the other.

The fumes and smoke here were very dense, and blew hither and thither with the wind, often hiding the view entirely. Away in the centre of the lava rose a great island of rock rather like Gibraltar in appearance. It stood out 100 feet above the surrounding level, and was doubtless a cone or core from some previous eruption. It was generally to be seen dimly through the drifting fumes.

Climbing down into the active crater we walked for a few hundred yards on the lava where it was not too hot. We had to choose our way carefully, jumping over the cracks and making sure that the heat was not too much for our feet. Occasionally we saw the red glow of molten lava down in the cracks, but here the heat was so intense that even a quick glance nearly singed our eyebrows off. The green sticks with which we were walking caught fire immediately when thrust into the cracks, and we lit cigarettes from a small fragment of stone we chipped from the red-hot sides. We walked warily, always looking back and half expecting the molten lava to burst out behind us and cut off our retreat. Occasionally we found the lava too hot for our feet and had to retreat.

By night the crater was a wonderful sight, even more grand than it was by day. Columns of flame burst up from the chimneys, lighting the pall of smoke which hung overhead. From a narrow crack in a huge black rock a white-hot flame 20 yards long shot out at regular intervals and with the report of a cannon. All night long we could hear the roar of this particular jet above the general noise of the crater. On the second night it was silent, and had no

doubt blown itself to pieces. Below us glowed a large area, several acres, of molten lava running in golden streams over the black surface.

Taking our lamps we walked cautiously back over the treacherous surface to our camp in a little wooden hut erected by the Belgians for observation purposes within the old crater. We were less than 300 yards from this inferno of molten lava and could hear the roar of the crater all night, yet it was bitterly cold, for we were 10,000 feet up, and in the morning everything was frozen.

SOME NOTES ON CONVENTIONAL SIGNS FOR TOPOGRAPHICAL MAPS

LIEUT.-COL. F. J. SALMON

IT has sometimes been advocated that conventional signs on topographical maps should be standardized by international agreement so that map users could visualize at a glance the country that is represented on any sheet, without reference to the legend. The information given on the bottom margin of a map is, unfortunately, used by the few. It is seldom referred to unless the reader is really in difficulties, and not always then. A universal system that could be drummed into every one at school would therefore have some advantages, but there are serious objections to it. Even if it were possible to use a uniform system to portray entirely different types of country, it would not be possible to get agreement between mappers of divergent outlook. Actually, each different type of country has a different system of mapping suited to it, while the principal uses to which the map is to be put will effect the style.

Certain conventional signs are easy to draw or reproduce, are clear to read, and may be conveniently used to represent quite different features in different parts of the world. The Ordnance Survey sign for shingle, for instance, may be successfully used to indicate moraines, rocks, or even some special types of vegetation, in countries where shingle does not exist.

The problem of the topographical map maker is to combine the colour, form, and texture of his signs so as to show the maximum amount of useful information required by different classes of map users without encumbering the sheet and reducing clearness and legibility beyond a certain point. Exactly where that point is must always remain a matter of opinion. One cannot aim at legibility only, as the maximum of clearness can only be obtained at the expense of useful information. Where there is sufficient demand, or where expense has not to be considered, much can be done by publishing more than one edition on the same scale, each omitting some colour or sign which its user is not expected to require. Thus, physical features may be omitted on a map showing different classes of cultivation or administrative areas, and vice versa.

We are all acquainted with the ambitious cartographer who tries to please all his clients by a map so cluttered with detail that it gives no general impression of the country and can only be read with a magnifying glass. Demands

Cliffs of the active crater

Sulphur fumes from the crater

Cliffs of the active crater

are, however, sometimes so insistent that it is necessary to turn out what is really a bad map in order to please those who, after all, do pay for it. In Ceylon the 1 inch is, virtually, an agricultural map and on many sheets the physical features are entirely masked by overprints of many colours which indicate tea, rubber, coconuts and other plantations. The planter likes his estate to stand out clearly and he is one of the chief users of the map.

In Cyprus there are, so far, only two small 1-inch sheets and these were published principally for the tourist. Some people do not like to be called tourists, and in deference to these the title "Visitors" map was used. Shortage of money limited the printing, which was done at the Ordnance Survey, to three colours. Later experience in Palestine makes me regret that the principal roads were not coloured with the contour brown.

One of the principal features of the Cyprus mountains, particularly in the Northern Range, is the great extent of broken rocky ground which cannot be classified as cliff, precipice, or outcrop. Entire hill sides consist of exposed masses of rock which have the appearance of boulders and which, though usually practicable for the active pedestrian, are very heavy going. It was obvious that here one had to depart from usual cartographical conventions and to distinguish this very rough country from grass or earth slopes. A sign similar to the Ordnance Survey shingle was used, but it had to be printed in black and this rather clogged the map though it considerably enhanced its usefulness.

Much the same sort of country exists in Palestine, but the problem is not quite the same, because the maps are not primarily intended for the tourist, though of course he has to be considered, and the greater demand and sale as well as the existence of a departmental reproduction plant, reduce the need for economy in colours. The same sign for rocky ground was used, at first, as in Cyprus, but it was printed in grey. The grey was found to be too near the black to avoid its interfering with the clearness of names and, moreover, visitors from the Lebanon were apt to misinterpret this rock sign for trees or scrub, as it is similar to the French standard symbol for forest, though of course very much smaller in size. The design was therefore changed to small and large dots and it was printed in mauve. The result was, I think, successful, provided the colour was kept uniformly faint, but variation in the printing density has caused some copies to be too strong, and there has been criticism.

The sign for rocky ground is now omitted from maps issued to those who do not require it, but I think it is important to warn the agricultural officer, the road engineer, the pedestrian, the airman, and the soldier that such areas are unsuitable for any but patch cultivation, are very rough going, bad for a forced landing, and impracticable for horses or wheeled transport of any kind. Although this sign is considered of military importance, the troops operating during the recent disturbances have, actually, not found it of much service. This has been due chiefly to the fact that they have been engaged in that part of the hills which is almost uniformly rocky and they know what to expect without asking the map. There is also the fact that they have not had to find practicable cross-country routes for artillery, cavalry, or transport and, when operating off the roads, have confined themselves to infantry skirmishes against terrorist bands.

ones in the active crater

It is possible that the ultimate solution will be a change in the ground tint of the map over areas of rock, though experiment may show that this gives a false impression of layering. If the country were uniformly hilly something could be done by changing the colour of the contours as do the Swiss cartographers when distinguishing barren slopes from grass and from snow and ice; but this necessitates a very high standard of accuracy in colour registration, not always attainable in a country where climatic change brings about rapid paper distortion.

Many water-colour drawings are started off with a complete wash of yellow ochre; much in the same way a buff ground-tint is often added to a topographical map to knit the colours together and to improve its appearance. This ground colour has been adapted as a descriptive sign in Palestine. It has been used in an attempt to distinguish the desert from the sown. The buff has been shaded off to white, on the Jerusalem and Nablus sheets, over the desert portions of the Jordan valley. The scheme is not entirely satisfactory, as the colour, if strong enough to show the distinction clearly, gives the impression that part of the map has been soiled by an oily stain.

There is a good deal of controversy as to what is cultivable and what is not, and the map is non-committal in that it merely describes the buff-tinted area as "crops and pasture" without any reference to the plain white paper to which it shades off on the east. Garden areas have been shown in solid green, and there is a green stipple and a green hachure for citrus and vines, while olive trees, shown in black, are distinct in shape from ordinary forest trees or pines.

Some have criticised all these distinctions and say that we are attempting to produce an agricultural map instead of a topographical one. On an English 1-inch sheet there are usually quite enough features from which one can locate oneself or find one's way without looking for different kinds of cultivation which moreover, in that country, may be frequently changed. In an open country like Palestine, an orange grove, a group of olive trees, a village garden, or the boundary of a vineyard are prominent and important details which help the map-user very considerably; and if, after all, a topographical map can, without damage to its clearness, show what areas are under orange cultivation, why not?

Most countries have some small characteristic feature which, owing to its relatively high topographical importance, has to be shown by a special sign. In France it may be a crucifix, in Ceylon an *ambalam* or way-side shelter, in Cyprus a lime kiln, and in Palestine a cave or heap of ruins which may be of archaeological importance or may shelter a brigand. A special little half circle sign is adopted in Palestine for a cave and a small ring of black dots, similar to that used by Kitchener in his Palestine Exploration Fund survey, indicates a *khirbe* or heap of ruins. A *khirbe* which may mark the position of a Canaanite fort, an Israelite town, a Roman camp, a Jewish synagogue, a Byzantine church, a Saracen or Crusader castle, an Arab village, or a Turkish post or Khan; may not only be of importance to the archaeologist, the geographer, and the historian but is a definite feature with a specific name and cannot be omitted from a topographical map. But there are so many of them. If time and money allowed of mapping on the 1/50,000 scale, their representation

would be a simple matter, but on the 1/100,000 scale, which it has been necessary to adopt, the inclusion of so many names, some of them rather long, has been difficult. Parts of the Hebron sheet have as many as ten to the square inch and it has been necessary to use a very small type which, though really quite legible, may require more than a casual glance to read. Much experimenting was necessary, and Caslon 8-point "lining old Italic" was finally selected. Where sufficient hand-letterers are available the personal touch can do much to maintain legibility, or squeeze a name into a small space, but skilled letterers are scarce in many parts of the world and mechanical typing has to be resorted to.

For a country so full of antiquities, an archaeological map is in much demand, and the survey which is shortly to be undertaken by the Palestine Exploration Fund will be recorded on special prints of the topographical series. This will probably mean devising a special system of conventional signs. On the present series of topographical maps the names of the principal antiquities that are considered to be of general interest to the public are printed in old English character. The use of this "ancient black" is not very logical, nor is such type clear to read or good for reproduction, but as it is very distinctive and catches the eye it is the most suitable for the purpose.

A word about colours. If manufacturers had taken as much trouble to produce unfadable printing inks and to classify their goods according to permanency as Winsor and Newton's have done with their artists' colours, the map printer would be in a better position. Many colours which may look very nice on a map will not stand up to exposure on a wall or to use in the field. Without knowing what one's inks are made of one can but experiment and expose them oneself, and this takes time. Many reds, mauves, blues, and yellows are apt to fade badly, and greys are so uncertain and liable to go green (owing to the fading of some red component), that it is usually safer to use diluted black.

There is one method of showing different types of land surface which, as far as I know, has not yet been tried; and that is embossing. In the same way as the brush marks on an oil painting can be reproduced in relief on a lithographic reproduction, so could a grained surface be used to represent rocky ground, and furrows to indicate orchards or some kind of cultivation. The practical production of such a map for certain purposes is not outside the bounds of possibility, though it would not stand much wear out of doors.

For office use a system that could be more often employed for showing information beyond that which a map can comfortably carry, is the use of printed tracings which can be superimposed on an ordinary map. Owing to possible distortion of the tracing paper the method is unsuitable where exact position is important but it can be used to show an immense amount of special information such as cultivation, population, geology, water resources, or the occurrence of pests and diseases.

THE COOK MEMORIAL AT POINT VENUS, TAHITI

IN September last we received a letter from Captain McComish, of Sydney, inquiring when the present memorial to Captain James Cook, at Point Venus, Tahiti, was erected or restored, whether it stands upon the site of Cook's observations of the transit of Venus, and the evidence for the association of the small piece of coral rock, now incorporated in the monument, with Cook. Captain McComish had arrived at certain conclusions of his own, and wished to have these confirmed or corrected. The following notes summarize all the information now available upon the history of this monument. It should be made clear at the outset that where references are made in these notes to the "monument" or to "Cook's stone," they are to the monument now standing about 100 yards west of the lighthouse at Point Venus.

In 1769, Captain Cook visited Tahiti to observe the transit of Venus. The *Endeavour* anchored off the north-east shore of Matavai Bay, and on April 15 Cook went ashore "to fix upon some spot, commanded by the ship's guns, where I might throw up a small fort for our defence, and prepare for making our astronomical observation. . . . We soon fixed upon a part of the sandy beach, on the N.E. point of the bay, which was in every respect convenient for our purpose, and not near any habitation of the natives. . . . The soil where we constructed our fort was sandy, and this made it necessary to strengthen the intrenchments with wood; three sides were to be fortified in this manner; the fourth was bounded by a river, upon the banks of which I proposed to place a proper number of water casks." [Hawkesworth's 'Voyages,' vol. 2, pp. 89, 94.]

Cook's account in his *Journal* (edited by Admiral Wharton, 1893, p. 68) is similar: "This afternoon (May 1st) we set up the Observatory and took the Astronomical Quadrant ashore for the first time, together with some other Instruments, the fort being now finished and made as Tenantable as the time, Nature, and situation of the Ground and Materials we had to work upon would admit of. The North and South parts consisted of a Bank of Earth $4^1/_2$ feet high on the inside, and a Ditch without, 10 feet broad and six feet deep: on the West side facing the Bay a Bank of Earth 4 feet high, and Pallisades upon that, but no Ditch, the works being at high water mark. On the East side upon the Bank of the river was placed a double row of Casks. . . ."

On Cook's 'Chart of the Island of Otaheite' a river is shown cutting the promontory called Point Venus, and leaving a narrow spit between it and Matavai Bay. To the west of this spit an anchorage is marked, presumably where the *Endeavour* lay, and it seems clear that the fort was built on this spit, where it could be commanded by her guns. The approximate position of the fort can also be seen from the plate No. 2, a general view from One Tree Hill.

The average width of the extreme portion of this spit appears to be about 200 feet. The dimensions of Fort Venus are not known, so that it is not possible to determine, in accordance with the above information, the exact position of the fort, but the position assigned to it on the sketch-map, which agrees with Captain McComish's conclusion, seems reasonable.

The next point to be settled is the site of the astronomical observations. The narrative of Cook's voyage as given by Hawkesworth is not definite on this point: the statement reads, "In the afternoon, of Monday the 1st of May, we set up the observatory, and took the astronomical quadrant, with some other instruments on shore, for the first time" (Hawkesworth, p. 111). Of the actual observations of the transit, it is recorded: "The observation was made with equal success by the persons whom I had sent to the eastward, and at the fort, there not being a cloud in the sky from the rising to the setting of the sun. . . ." (p. 140).

It seems clear therefore that the observations were made in or close to the fort, though in some passages the term "the observatory" is used, but whether in contradistinction to "the fort" or no is not apparent.

Cook's *Journal* (p. 62) makes the connection between the fort and the observations clearer: "I therefore without delay resolved to pitch upon some spot upon the N.E. point of the Bay, properly situated for observing the Transit of Venus, and at the same time under the command of the Ship's Guns, and there to throw up a small fort for our defence." The quotation from the *Journal* already given also stresses the relation between the "observatory" and the fort. The whole purpose of the fort was to protect the instruments, especially as the natives were much given to pilfering. It seems reasonable to assume therefore that the observations were taken from the fort.

On this voyage Cook took the latitude of the point of observation to be 17° 29′ 15″ S.—this being the mean of a number of observations. On his chart of Tahiti accompanying the narrative of the voyage—in constructing which he presumably used this determination—this parallel lies slightly to the south of the extremity of Point Venus, and, in fact, cuts the spit in the approximate position assigned to the fort above. Though this circumstance cannot be relied upon entirely, it tends to show that the observations were made at the fort.

It should be noted that the distance between the present memorial and the site of the fort is probably not more than 300 yards, and may have been considerably less.

There is no record in the accounts of his three voyages to show that Captain Cook set up any kind of rock or monument to mark the site of the "observatory." None of the navigators, such as Kotzebue, Beechey, Belcher, Dumont d'Urville or Wilkes, who touched at Tahiti after Cook's visits, refer to the existence of such a mark. Kotzebue however records a tradition about the position of the observatory: "By the influence of Wilson, a small house situated on Cape Venus was cleared for our astronomical observations; we were told that it stood precisely on the same spot where Cook's observatory had formerly been erected" (Kotzebue, O. von: 'Voyage of discovery into the South Sea, etc., 1815–18,' vol. I, 175–6). On his plan (facing p. 200) the observatory is shown near the extremity of the spit. This was in 1824, forty-six years after Cook's last visit. On the plan contained in Dumont d'Urville's hydrographic atlas—*Plan de la Baie Matavai, Sept.* 1838—the word "Observatoire" is written along the extremity of Point Venus, but there is no symbol to mark its exact position, no reference to its connection with Captain Cook, nor is any other monument associated with Cook shown. There is therefore no

evidence before 1840 for the existence of a stone associated with Captain Cook.

In 1899 Mr. A. L. Anderson wrote to the President of the Society (Sir Clements Markham) stating that he had recently visited Point Venus, Tahiti, "the spot from which the transit of Venus was observed by Capt. Cook in 1769." He then described a stone, which he tacitly assumed to be "Cook's stone," and its condition: "Sunk in the ground there is still to be seen the coral slab placed by the great navigator; it is about a foot square and has a brass plate, perhaps four inches square (and showing the transit line) let into its top. . . . As I saw it, the stone was exposed to the tender mercies of goats, children, dogs, cattle, etc. having no protection whatever." He had asked the local authorities for permission to fence round the memorial, but this had been refused. He therefore suggested that the Society should obtain permission to "erect a monument on, or a fence around this stone."

The Council agreed to do this, and secured the co-operation of the Royal Society. At their request, H.B.M.'s Consul at Tahiti obtained permission from the Governor of the Colony to erect a monument; in submitting plans for this, he suggested that the Society should send out a suitably engraved brass plate to be placed on the monument. This was done, but while the plate was on the way out, the Consul informed the Society that the Governor had undertaken to set up the monument at public expense. A line was accordingly interpolated in the inscription to record this, so that it reads, "This memorial, erected by Captain James Cook to commemorate the observation of the transit of Venus, June 3rd 1769, was restored and fenced round by the local Administration at Tahiti and this plate was placed here by the Royal Society and the Royal Geographical Society in 1901." The monument when finished consisted of a column, surmounted by a sphere, standing upon a plinth in which the stone referred to by Mr. Anderson is embodied—the whole being enclosed within an iron railing.

According to the Admiralty Pilot this monument stands about 100 yards west of the lighthouse on Point Venus. The Pilot further describes the stone as 15 inches square, and marked with a meridian line. Captain McComish describes it as "a flat piece of whitish stone (or dressed coral ?)," $12 \times 9\frac{1}{2} \times 2\frac{1}{2}$ inches, having in its centre a piece of brass about 4 inches square with a groove across it, pointing directly south-west to the Dolphin Bank. He was also told that the memorial, or part of it, had formerly been situated farther west, towards the shore of Matavai Bay, and hidden by vegetation. There appears to be no record of the stone having been moved; Lieut. Le Clerc (see below) speaks of what was probably the same stone having been a few yards west of the lighthouse in 1870.

After this memorial had been set up, Mr. Kyngdon wrote to the Society from New Zealand asserting that the memorial had been placed at the wrong stone, for another stone on Point Venus was locally associated with Captain Cook. In reply to an inquiry from the Society, the Consul investigated the matter with these results:

A tradition of the association of the stone, over which the memorial had been built, with Captain Cook was very strong locally, and the stone was in fact known as "Cook's stone."

Prince Hinoi Pomare, a member of the former ruling house, asserted: "Mes ancêtres m'ont montré jadis une pierre située à la point Venus, et m'ont dit que cette pierre avait servi autrefois à l'illustre navigateur et astronome Cook pour point de repère de ses observations," and testified that this stone was that incorporated in the monument.

Another inhabitant described how, in 1868, when he was working as a carpenter on the building of the lighthouse, many visitors, particularly French and British naval officers, came to see the stone set up by Captain Cook, and he added that this was the stone incorporated in the monument. It is clear therefore that local tradition from at least 1868 associated this stone with Captain Cook, and that this stone did not stand on the approximate site of his fort.

The stone referred to by Mr. Kyngdon, the Consul had ascertained, had been placed in position by Commander Wilkes, U.S.N., in 1839. The following extract describes its purpose:

"I was desirous, in addition, of ascertaining with precision the least depth of water on the Dolphin Shoal, and had employed boats in making accurate soundings. The results, however, were so unsatisfactory, on account of the ever-varying level of the tide, that I could not hope that they would serve for a reference by which to ascertain the future increase of this bank, by the growth of the coral. I therefore planted a large stone, with a horizontal surface, and having found the shoalest place on the bank, carefully measured the difference in the height of the surface of the stone and the rock of the bank, by an excellent spirit-level. I then caused a mark to be traced upon the surface of the stone pointing towards the place on the bank where the levelling staff had been placed. The difference of level was twenty-five feet seven inches. Old Tana, the chief of the district, promised me that he would taboo the stone, and that it should not be touched or disturbed on any account; and, to preserve it from any accidental disturbance it was set four feet into the ground" (Wilkes, U.S. Expl. Expedn. 1838–42, vol. 2, p. 40).

It will be noticed that Wilkes does not give the exact position of the stone, nor is it marked upon his charts. On the French chart "Plan de la côte septentrionale de Tahiti," however, made by Lieut. Le Clerc and others in 1869, and published in 1874, a "Pierre de Wilkes" is marked on the spit on the east side of Matavai Bay. The Consul, in 1902, stated that Wilkes' stone was distant "say 400 feet" from the memorial.

The Consul's further researches brought to light in the Official Gazette of Tahiti an account of the verification of the position of Wilkes' stone in 1870.

The Commander-in-Chief of the French Naval Forces in the Pacific had sent Lieut. Le Clerc to verify the position of Wilkes' stone. This is said to be of basalt. Lieut. Le Clerc placed on either side of it, apparently at some distance, a slab of coral, each with a piece of copper let into the top; it is stated that a similar piece of copper had been let into a coral slab situated a few yards west of the base of the lighthouse, but it is not definitely stated that this slab was placed in position by Lieut. Le Clerc. In view of the strong local tradition that the latter stone was in existence and in position long before the lighthouse was built in 1868, the Consul did not believe he had done so.

This stone of Wilkes', with the two guiding stones, was visible in 1902, but

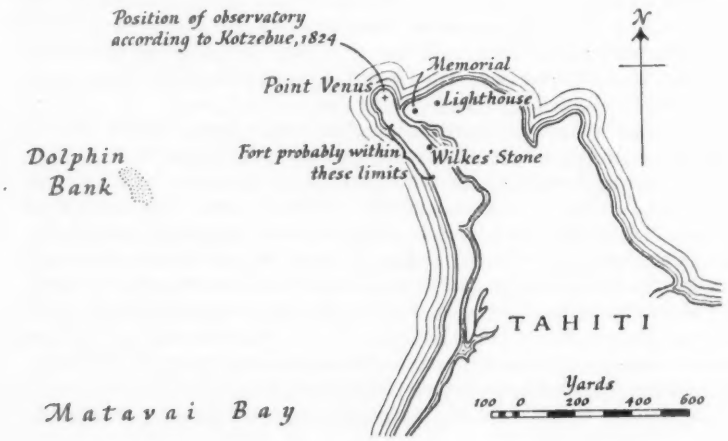
has apparently disappeared, as Captain McComish failed to find it between 1922 and 1933.

Dr. R. W. Coppinger, the surgeon on H.M.S. *Alert* during her surveying voyage in the Pacific, took the opportunity, when she was lying at Papeete in August 1880, to visit Point Venus, and records his impressions thus: "A few days after our arrival at Papiété, I made an excursion to Point Venus, the northern extremity of Matavai Bay, in company with a party of our surveying officers, who wished to take sights at this station for chronometric measurements for longitude, Point Venus being one of the secondary meridians to which longitude in the Pacific are reckoned. The French keeper of the lighthouse, who was most obliging, pointed out to us a square slab of coral rock imbedded in the ground, and bearing on its surface a deeply-chiselled groove. It was placed there some ten years ago to replace one which had been fixed there in the year 1839 by Captain Wilkes of the United States Exploring Expedition, and was, I understand, intended to assist in determining the exact position of a submerged coral knoll, some hundred yards from the shore, on which measurements were made for determining the rate of growth of the coral" ('Cruise of the *Alert*,' p. 149).

From the description, it would appear that Coppinger saw "Wilkes' stone"; he is mistaken, however, in suggesting that it had been replaced ten years before by Lieut. Le Clerc. The important point of his account seems to be that the lighthouse keeper never mentioned Cook's name to him in connection with a stone, for it is unlikely that he would have omitted to record this.

The conclusions to be drawn from the above are: Cook's observations were made at Fort Venus, and not on the site of the present memorial; Cook does not appear to have set up any mark or rock, and no references are made by early visitors to a mark left by Cook; the stone incorporated in the present memorial was associated by local tradition with Cook, but the origin of this tradition cannot now be determined; and the inscription on the brass plate is unfortunately misleading.

G. R. C.



GLACIOLOGY OF THE GREENLAND ICE-CAP

WISSENSCHAFTLICHE ERGEBNISSE DER DEUTSCHEN GRÖNland-Expedition Alfred Wegener 1929 und 1930/1931. Edited by KURT WEGENER and others. Band III. Glaziologie. By BERNHARD BROCKAMP, HUGO JÜLG, FRITZ LOEWE, and ERNST SORGE. *Leipzig: F. A. Brockhaus*, 1935. $10\frac{1}{2} \times 6\frac{1}{2}$ *inches;* viii + 270 *pages; illustrations and sketch-maps.* *M.*17.75 [£1 9*s* 9*d*]

THE glaciological results of the Wegener Expedition consist largely of Dr. Sorge's observations made during the winter at Eismitte and the conclusions since deduced. Four other contributions however deal with the glacier fronts of the Umanak district, the glaciological work at the West Station, the information given by the seismic sounding as to the deep ice temperatures, and precipitation observations at intermediate stations.

Dr. Loewe describes the present state of some West Greenland glaciers in a district which has been visited by Giesecke, Rink, Steenstrup, and v. Drygalski. The information about fourteen glaciers of the Umanak region is summarized to determine how far variations in the position of the ice-front can be considered as expected irregularities or as evidence of any alteration of conditions. The general conclusion is that no significant changes can be found. The West Station party had opportunities to make a useful summary of the conditions at the margin of the ice-sheet. But the greater part of Dr. Jülg's contribution describes the building of the shaft put down below the floor of the West Station. Considerable resolution must have been necessary to get this shaft dug; not only was the work arduous, but the doing of it disturbing to the occupants of an already overcrowded station. A depth of 20 metres was achieved. This compares with Koch and Wegener's 24-metres shaft made in 1913 in North-East Greenland, and the 15-metres shaft dug during the 1931 expedition by Sorge. The West Station as it appeared later stood on a mass of ice only 140 metres deep, which did not partake of the motion of the surrounding glaciers, from which it was separated by crevasses. It is somewhat surprising that the temperature gradient shows a transference of heat from below of the same order as that found by Alfred Wegener at his station on the great glacier Storström.

As far as the main body of ice itself is concerned, the digging of shafts is a very laborious way of getting results from which only very doubtful general conclusions can be drawn. The upper layers are subject to radiation and to rapid physical changes: the thermal properties of the *firn* are certainly different from those of ice. So if any conclusions can be drawn from seismic observations much is gained. Dr. Brockamp recalls that the speed of both the longitudinal and the transverse waves is related to the distance from the coast, or alternatively to height above sea-level. He then considers in detail the moduli of rigidity, elasticity and compressibility as given by the transmission speeds at the station 120 km. from the coast. From them he deduces with excellent agreement between the three approaches a temperature of −16° C. at 180 m. depth. This leads to the conclusion that of the supposed 1800 metres of ice below the station, the greater part is at temperatures below 0° C.

Sorge's glaciology from Eismitte takes 210 of the 270 pages of the book, but possibly the very detailed description of technique and the extended style of argument is necessary in a case of this kind. No details are missing and it is easy to form a lively conception of the conditions under which the work was carried out. The lengthiness of the discussions nevertheless makes it sometimes difficult to locate the conclusions. It was a very low temperature research

station with generally only −15° C. on the floor and something between −5° C. and −10° C. on the table. The men tended to keep in their sleeping-bags when sitting at the table. The ice out of which bunks and table had been hewn caused clothes and sleeping-bags quickly to be worn and damaged, so that one sympathises with the statement: "For two men the continual mending, cooking and nursing (of Dr. Loewe) was a heavy handicap to the scientific work." An unexpected trial was that when the bad weather came and the outside temperature rose by perhaps 20° C., the temperatures at the station so far from partaking of such a welcome change in climate fell by another 5 or 10 degrees, because of air drawn into the living room from the pores of the inland ice itself.

The two active occupants of Eismitte divided their territories of work at the surface of the snow, so that while Georgi was concerned with what went on above, Sorge's researches were subterranean and almost entirely concentrated on digging and taking measurements in the 15-metres shaft. In the order of publication the first quantity observed is the density of the material from the time it is deposited as snow until it has changed some way towards the consistency of ice as layer after layer of snow is deposited above it. The method used was to saw out blocks, measure them and weigh them on a Roman steelyard. Very good results were obtained, consistent to the third decimal place. These measurements revealed a layering of the material which soon showed itself to be due to the alternating conditions of summer and winter. The hard, dense layers were the winter layers, consisting of the finer grains of the winter snowfall compressed by the greater winds. This is a reversal of the conditions at the margin of the ice, where summer thawing and rainfall make the corresponding layer a hard one. Nevertheless in one horizon ice was found in the layers examined below Eismitte, in the one corresponding to the summer of 1923, when exceptional warmth was experienced in Greenland. In that year there must have been even at Eismitte a brief period of thaw, although during the year of the observations the absolute maximum air temperature recorded was −2·7° C. The fact throws light on the recent discovery of the Oxford University Expedition to North-East Land, that little of the ice of that low plateau is at a temperature below freezing-point: that in fact only under extreme circumstances is "cold" ice possible.

From the measurements a mean precipitation could be computed, which was found to be about 31·4 cm. expressed as rainfall. The snow is continually subject to increasing pressure from the layers above, and its density increases. But a very surprising observation was a sharp and unforeseen change of rate of increase at 7 metres depth, when the compression seemed to have brought the snow to a state beyond which further increase of density took place at a much reduced rate. This compression of the layers of snow was somewhat embarrassing for the occupants of the dug-out which was their winter quarter. As time went on the headroom diminished alarmingly. Another feature of the settling of the snow, the famous *Firnstoss*, or ice-quake, took place three times, and though the German investigators seemed to have expected it more than did Mr. Courtauld in his lonely tent a few hundred miles further south, nevertheless they were just as terrified of this rumbling and crashing of the ice-plain. Fortunately in neither case was there any material consequence of this disturbance.

The temperature measurements are made the subject of a very careful analysis, which leads to the remarkable discovery that in the upper layers the mean temperature of the ice, after accounting for the superimposed effect of summer and winter, actually decreases with increasing depth. This conclusion is quite at variance with anything that might have been expected. Dr. Sorge argues that though the existence of the living-room might be held responsible

for a downward flow of heat, actually the disturbance caused by this factor was too slight to produce the measured effect. So he interprets it as evidence of a recent increase of the yearly mean temperature, *i.e.* a change of climate. The regular Danish observations at the coastal stations do in fact show a difference of some +2° C. between the mean for the years 1926–30 and for the years 1913–25. The change in the middle of Greenland would probably be only half that amount.

These results, which can be considered as the work of an unassisted individual, bear witness to considerable determination in the making of observations in circumstances that were certainly by no means pleasant. Their value will be greater now that further work has been done in Spitzbergen to compare with Wegener's and Koch's classic effort in 1913, and that planned by Wegener for Dr. Sorge in 1930–31. To fit these results into the work of the expedition as a whole the interested reader is referred to *Geogr. J.*, December 1934, where will be found the story of the expedition and an account of the hitherto published scientific results.

MICHAEL SPENDER.

REVIEWS

EUROPE

HOCHBULGARIEN. II. Sofia. Wandlungen einer Grossstadt zwischen Orient und Okzident. By HERBERT WILHELMY. (Schr. Geogr. Inst. Univ. Kiel. Band V. Heft 3.) *Kiel*, 1936. $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* xii+220 *pages; illustrations and plans.*

BULGARIA, Past and Present. By GEORGE CLENTON LOGIO. *Manchester: Sherratt and Hughes*, 1936. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* viii+480 *pages; illustrations and maps.* 12*s* 6*d*

Dr. Wilhelmy's book on Sofia continues, and apparently concludes the author's study of the cultural geography of Upper Bulgaria. Though the work has possibly more historical than geographical interest, yet it affords a fascinating glimpse of the transformation of Sofia from a small oriental town of some forty or fifty thousand inhabitants, at most, to a large modern city containing nearly three hundred thousand people. Besides dealing with this main theme, the author also sketches the importance of the position and site of the town and traces its chequered career from prehistoric times, through the Roman period, the troubled early Bulgarian and Byzantine epochs, up to the coming of the Turks, and he then proceeds to describe the conditions of life in the town during the five centuries under Turkish rule.

The importance of the position of Sofia is well known, but Wilhelmy throws much light on the advantages of the actual site by means of an interesting map showing the relation between the original settlement (now the centre of the city) and the lower of the two main terraces of the Sofia basin, namely the "Sofia" terrace. He also shows how the marshy ground below the terrace long hindered building operations, and he then proceeds to trace the subsequent expansion of the city on to the higher or "Kuru Baglar" terrace, a development which has taken place only in post-war days. Actually, the drainage of the marshy ground must be put to the credit of the Turks, who also in their own fashion made the city one of the finest in the Ottoman Empire, though the actual numbers of inhabitants remained small. It is interesting to note that the conquering Turks immediately recognized the importance of the position of Sofia, by making it the seat of the provincial government of Roumelia, a province comprising the area covered by modern Bulgaria, Rumania, Macedonia, Albania, and Greece. On the Turkish conquest, the aspect of the city became entirely oriental, and only one or two buildings, of which the most important was St. Sofia, survived from pre-Turkish times. According to Wilhelmy, the name Sofia only gradually gained ground over the old name of Sredec, which remained in local use, although the name Sofia appears in a Russian document as early as the fourteenth century.

The transformation of the city to a "western" aspect began as late as 1881, following on the liberation of Bulgaria as a result of the Russo-Turkish War of 1876–78. The work of reconstruction was indirectly aided by the fact that the city was semi-deserted and derelict, a state of affairs due partly to the great plague of 1837, partly to the flight of the Turkish inhabitants, and partly to the depredations of the Russian garrison, who obtained their fuel by removing beams and other timbers from the houses. Unlike the Turkish town, which was completely devoid of symmetry, and contained meandering streets of varying width set at haphazard angles to each other, the new city was constructed on a rectangular plan, so that it now presents a very modern and up-to-date appearance.

The author illustrates the growth of the city by means of a number of maps, black-and-white sketches and aerial photographs, showing clearly the recent great extensions, particularly since the 1919, and he concludes his study with an account of the industries which have grown up in and around the town.

Mr. Logio's book presents a contrast in many ways to Dr. Wilhelmy's monograph. While the latter has the detachment of the scientific outlook, the former contains all the warmth of partisanship; while Dr. Wilhelmy writes as a spectator from a distance, Mr. Logio writes as one actually in the arena. Unfortunately, the book was printed in Bulgaria, it is badly produced, and contains innumerable errors in printing, while its style is occasionally a trifle florid, especially in the opening chapters. No one however should allow himself to be put off by these blemishes, since here is perhaps the best-informed and most outspoken book which has yet appeared on Bulgaria. Sound sense and accurate information characterize the whole of the bulky volume, which is packed full of interesting material for whoever wishes to study the present-day conditions, though it may very possibly displease both English and Bulgarian politicians.

The scope of the book is wide, but, broadly speaking, the author aims at providing an explanation of the present and past political difficulties of Bulgaria, whether internal or international. The book opens therefore with a study of the present political situation. It continues with chapters on the Treaty of Neuilly and on the League of Nations Loan, and then proceeds to set the political and financial problems against a firm geographical background, by means of a very capable analysis of the agricultural and other natural resources of the country. A short section on education in Bulgaria and on various cultural aspects of the national life follows, and the author concludes with an historical account of the Bulgarian people from earliest times up to the present day. The book is adequately indexed and contains numerous illustrations. M. R. M.

LES GRANDS CAUSSES. By PAUL MARRES. Tome I. Le milieu physique; pp. 214. Tome II. Le labeur humain; pp. 446. *Tours: Arrault et Cie*, 1935. 11½×8 *inches; illustrations and maps.* 170 *frs.*

The arid limestone plateaux of the Grands Causses, flanking and embedded in the crystalline block of the Central Massif of France, form so outstanding a physical unit and exhibit characteristics so peculiar as fully to justify this elaborate study. Their peneplaned surfaces offer a variety of rock exposure that expresses itself in the vegetation and in the rural economy; but karstic conditions, owing to the predominance of limestone in the exposures, prevail, and are reflected, not only in crop and population distributions, but in the major industry of the district. The author devotes some ninety pages to structure and relief, in which he elaborates and illustrates M. Baulig's theories on the peneplanation of the Causses, and then proceeds to a detailed study of the karst landscape, showing the important part played by the dolinas or "sotchs" in the dissection of the surface. The work is admirably illustrated by sketches and plans.

The chapter on climate brings out well the dominance of Mediterranean factors in summer and of continental influences in winter, but draws attention also to the importance of the ding-dong changes of wind direction, due to the passage of cyclones from the Bay of Biscay to the Gulf of the Lion—the *grec* from the south-east, the *traverse* from the west and the *bise* from the north—with the resulting sudden alternations of warmth and bitter cold, of rain or snow and drought. M. Marres supplements the generalizations from none too satisfactory weather records by reference to the vegetation cover, as a more reliable indication of the sum of climatic conditions. The once forested Causses are largely bare to-day, but climate has been the dominating factor in determining the

reaction of vegetation to human interference. Thus, on the Larzac plateau, oak, which has been dominant since earliest records, though represented actually only by degraded remnants, probably replaces the beech, which was unable to re-establish itself after deforestation and has now retreated to the milder and more humid western slopes. In northern Larzac *pinus sylvestris* has been well established since the eleventh century at least, its hardy nature enabling it to stand up against the harsher climate of the Grands Causses de Gévaudan. The vegetation of the Causse Noir, with *pinus sylvestris* in the north and *thymus vulgaris*, a well-established invader from the south, is interesting from the same point of view. Here lies the boundary between the southern and the Grands Causses.

Volume II deals with human labour in an essentially rural area. The author traces the economic history of the Causses through the eighteenth century to the present day, examining the change from an economy of grain and wool farming with a cottage and village textile industry to the actual system, in which sheep rearing to supply milk for the Roquefort cheese industry dominates the rural economy, and agriculture is reduced to mixed farming for local food supply. The textile industry is dead or moribund, but the glove industry of Millau, for which lamb-skins form the chief raw material, flourishes, working in well with the demands of the cheese factories.

Most interesting are the details given of the cheese industry, whose large-scale development and concentration at Roquefort was based almost entirely on the extraordinary natural refrigerating, ventilating, and air-conditioning apparatus provided by a system of caverns aligned along a fault, where a tumbled mass of great limestone blocks are detached from the main plateau of the causse. In the valleys, where life is cramped and more difficult than on the plateaux, agricultural effort is concentrated on forage cultivation: irrigated hay, lucerne, etc., for the causse farmers.

A description of each of the various causses in turn is followed by a chapter on rural dwellings, with a large number of plans and illustrations. The ubiquitous cistern and the *bergerie* below the dwelling-house characterize the causse farms, however much they may vary in other respects, and seem to summarize the life of these desolate uplands, emigration from which, despite the revivication afforded by the modern organization of the cheese industry and the revival of glove making, still presents a disquieting problem. H. O.

A GEOGRAPHY OF EUROPE. By RAOUL BLANCHARD and RAYMOND E. CRIST. *London: Methuen & Co.*, [1936]. 9×5½ *inches;* xviii+490 *pages; illustrations and maps.* 12*s* 6*d*

It is not apparent that this book, written by Professor Blanchard, who holds the Professorship of Geography at the Universities of Grenoble and Harvard, has ever appeared in a French version. It was expressly prepared for "students and the general public of North America," but the present edition was printed in America though published in England, and the translator claims that it makes "accessible to the great English-reading public an up-to-date Geography of Europe by a recognized authority." In view of this claim, it would surely not be too much to expect that those parts of Europe where the English language is spoken would be described with meticulous accuracy. It is with some astonishment therefore that the reader learns that Monmouth and the Forest of Dean are in Wales (p. 94), that the coast of south-west England is noted for "*sardines*, mackerels *and fresh fish*" (the italics are ours), that "sheep are no longer raised on the [South] Downs" (p. 103), and that to the east of the mountains of Wales "is the broad old border of Shrop and Hereford" (p. 94). To prolong this list

of errors would only be wearisome, but unfortunately the selection given by no means exhausts their number. It is perhaps significant that the bibliography makes no mention of the two most recent and well-documented volumes on the British Isles, namely 'Great Britain,' edited by A. Ogilvie, and 'The British Isles,' by Stamp and Beaver.

As the book proceeds the reader becomes accustomed to such Americanisms as "a fine breed of cattle grazes in the open and is fed beet roots"; but it is open to doubt whether some of the sentences are even good American, *e.g.* "The Rhine valley is one of the economic arteries of Germany, which in the Ruhr district crosses that section which follows the edge of the Hercynian mountains" (p. 238), when there has been no previous reference to any "section." Two other features of the book may appear strange to English readers. First, the use of foreign words without italics, inverted commas or translation, but just as if they were recognized components of the English language; and secondly the use of French versions of place-names. As examples of the first we find such phrases as "coarse alluvions," "the renters on the landed estates," the term "strassendorf" applied to a Scottish village, "slickensides," "socles," and many others. In regard to the second idiosyncrasy, we may possibly be prepared to accept the "Gulf of Gascogne" as a substitute for the "Bay of Biscay," and it is somewhat intriguing to find "Lusace" concealing the identity of "Lausitz," but it seems hardly necessary for Irish Errigal to masquerade in one of the maps as "L'Errigal."

In regard to the material of the book, Professor Blanchard's powers of description are displayed to good effect in the regional sections, some of which are very useful, though again the reader constantly finds statements which the charitable may assume to have suffered a change in the process of translation. It is interesting, for instance, to speculate on the original of the following sentence: "a first platform of the lower and middle Triassic (Gau) descends from the edge of the border of the Rhine plain to elevations of from 1000 to 1300 feet." There are other statements however such as "Flanders owes its remarkable prosperity to its splendid rivers" (p. 43); "the Basin of Aragon is a replica . . . of the Aquitania Basin of France" (p. 315), which are very misleading even on the most favourable interpretation, and can hardly be attributed to faulty translation.

It can scarcely be imagined that information of this type will serve to interpret the continent of Europe at all adequately, either to students or the general public of North America, though there are compensations in the numerous excellent photographs and in the very wise and stimulating section entitled "The Human and Economic Factors of Europe."

The maps and diagrams, which are not even numbered, are disappointing, and do not add greatly to the value of the book. M. R. M.

WALKING IN DORSET. By JOAN BEGBIE. *London: Alexander Maclehose & Co.*, 1936. 8×5 *inches;* xiv+366 *pages; illustrations and sketch-maps.* 7*s* 6*d*

WALKING IN CORNWALL. By J. R. A. HOCKIN. *London: Alexander Maclehose & Co.*, 1936. 8×5 *inches;* xxiv+294 *pages; illustrations and sketch-map inside cover.* 7*s* 6*d*

The chief impression on the reader's mind after struggling through these two volumes is that they are trying to meet a need that does not exist. To walk in Dorset or Cornwall is undeniably a delightful thing to do; to read about some one else's walks there is apt to become distressingly tedious.

Miss Begbie, in her far too lengthy account of Purbeck, gives minute details of her cross-country routes and repeats again and again the same features of distant views; every true walker takes pleasure in noting these things for himself

and may even write them down for his own delectation, but few can want to have this done for them by others. Miss Begbie quickens up when she leaves her justly beloved Purbeck, and the west Dorset coast is taken much more rapidly—in fact, she almost runs over Golden Cap, its crowning point. Later on in a chapter entitled "Much in Little" she is reduced to summarizing many towns and villages in the ordinary guide-book manner. She cuts out Portland, justifiably perhaps, and does not appear to know much about the Stour gap with its two entrenched hills. She tells us very little about one of the outstanding features of Dorset, the array of old manor houses with their musical names. Her pages are enlivened by her thumb-nail sketches, but her maps are poor.

Mr. Hockin starts off well, taking us fairly briskly along the south coast from Plymouth Sound to Mount's Bay *via* the Lizard (where his remark about "the deadening effect of the serpentine plain" seems to show he has not seen it when the white heath is in bloom). But his route south-westwards down the north coast includes many complicated inland byways passing strings of tiny hamlets which, it may be suspected, have been introduced for the sake of their highly attractive Celtic names. To follow him almost requires the O.S. 6-inch sheets; the sketch-map inside the cover is of very little use. It is with a sense of relief that we finally reach Penwith and the Land's End. Here Mr. Hockin's enthusiasm runs away with him and makes him speak of "the terrific escarpment of the moors." The quotations from the Elizabethan Carew are amusing.

J. H. R.

ROMAN BRITAIN AND THE ENGLISH SETTLEMENTS. By R. G. COLLINGWOOD and J. N. L. MYRES. (The Oxford History of England. Edited by G. N. CLARK.) *Oxford: Clarendon Press*, 1936. 9×5½ *inches;* xxvi +516 *pages; maps.* 12*s* 6*d*

This book is a comprehensive and well-proportioned survey of Britain down to the end of the sixth century A.D., a period for which documentary evidence both direct and indirect is very scanty, and archaeological evidence, though in recent years greatly increased, not always easy of interpretation. To quote Mr. Myres, "When finality is impossible, the subjective element inherent in all historical writing finds full play." We have here a fresh synthesis of the materials made under these conditions, and it may be said at once that it is a masterly one and as convincing as any synthesis could be to date. There is no living writer who can claim the authority of Mr. Collingwood on Roman Britain, and probably no other author could deal with the obscure early Saxon period with the knowledge, judgment and restraint of Mr. Myres. In a sense the two writers are independent, and their views are not fully in accord on all points. Mr. Collingwood is responsible for the first four books, of which the first gives a sketch of Britain before the Roman Conquest, down to the Bronze Age, in the time of Julius Caesar, Caesar's invasion, and the interval between Caesar and Claudius. In Book II, the Age of Conquest, the chapters are concerned with the Claudian invasion, the resistance of Caratacus and Boudicca, the period from Boudicca to Agricola, the making of the frontier, and its history from Hadrian to Septimius Severus. The third book, the longest and probably the most valuable, is a full survey of Britain under Roman rule, under the headings of the machinery of government, the people, the towns, the country-side, industry and commerce, art, and religion. The end of Roman Britain (Book IV) is viewed in three stages, from Severus to Honorius, the end of Roman rule, and Britain in the fifth century. The story of the English settlements is taken up in Book V by Mr. Myres, under five chapter headings: the sources for the period, and Angles, Saxons and Jutes on the Continent—the course of the conquest in Kent and the

south-east—the Fenlands, East Anglia and the problem of Wessex—the Humbrenses—and the character of the conquest. The volume closes with a full and excellent bibliography of 27 pages, and an index. The lay-out of the subject-matter is what might be expected, but interpretations of archaeological discoveries, inferences drawn from historical analogies, and methods of treatment are often fresh and result in an appreciable advance in knowledge. Thus it is all to the good that the Roman period is not viewed as an isolated episode, but as one in which the British people, with a historical tradition of their own, learnt from Rome what their previous training fitted them to learn. As to the amount of continuity there was in the very obscure century and a half between A.D. 440 and 593 Mr. Myres is far too cautious to dogmatize. He is content to represent the period as a cultural phase in our history very different from Roman Britain on the one hand and from Christian England on the other: he restricts himself mainly to an account of the settlement of the English in Britain. Making judicious use of the evidences, Mr. Collingwood constructs the history of the more civilized part of Britain between Caesar and Claudius round five realms—those of Cunobelinus, Epaticcus, the Iceni, Dobuni, and Brigantes. He gives a convincing narrative of the Claudian invasion and the battles fought, the engagement at the Medway being the decisive factor. By selecting the most probable probabilities he works an intelligible canvas of the Plautian campaigns from London, and of the Fosse Way as a frontier line drawn by his successor Ostorius and studded with auxiliary units patrolling their respective neighbourhoods. In these and similar episodes "presumably" must be much in evidence, but the margin of error is undoubtedly small and Arthur, Artorius, Dux Bellorum and the last of the Romans, are accepted. Want of space prevents the reviewer from going into detail on a few debatable points, and it must suffice to say that Mr. Collingwood's narrative as a whole is admirable in clarity and persuasiveness. Mr. Myres labours under the great difficulty that for his period archaeology is still in its infancy. As to the Jutes he favours the view that the Jutish nation was made after the conquest in Kent, and that the settlements in the Isle of Wight and on the Hampshire coast were later offshoots from Kent, after the South Saxons had settled along the Sussex coast. He might have made still more of his thesis that Saxon cemeteries tend to be on the lines of Roman roads. We await the development of research for this period. S. E. W.

THE OLD TOWNS OF ENGLAND. By CLIVE ROUSE. *London: B. T. Batsford*, 1936. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* viii + 120 *pages; illustrations and plans.* 7*s* 6*d*

This is an attractive book with a fascinating subject, liberally and well illustrated. The number and variety of old English towns are great, and, within his space the author naturally cannot deal with them all, nor indeed fully with any. The pace is rapid and the kaleidoscope dazzling. The author deprecates the claim of the passing motorist really to see such towns, but his text goes through a great many of them with much the same brusqueness. We have a full selection of cathedral cities, market and country towns, ports, health resorts and spas, made intelligible by a modicum of historical reminders. After an adequate introductory sketch of the growth of our towns, the author proceeds to describe with zest samples of the four roughly classified kinds of town above named, along with their traditions, noting that it is the buildings themselves and their setting, *e.g.* in the case of Lewes, that really count. Our towns are going through a critical time. Adaptation to modern developments is of course necessary, but it must be secured without blotting out evidences of centuries of evolution. Wherever possible, the author urges, the aim should be the reconditioning rather than the destruction of old buildings. We hope these pages will help to stimulate

the formation in towns of Preservation Societies, such as that of Steyning. Though most of the photographic views have been carefully chosen so as to exclude them, commercial advertisements come prominently into some of them. This is a point demanding attention. Within his limits the author makes the most of his theme, developing it with humour and eloquence. A reader can hardly expect to find all his favourites emphasized or mentioned, but cannot grumble when he is given so much. One may have visited many of these towns, and yet not realize how rich is our heritage till he sees them gathered together in such a collection as this. Mr. Rouse will whet the reader's desire to see leisurely what he has not yet seen. S. E. W.

THE PARISH CHURCHES OF NORFOLK AND NORWICH. By CLAUDE J. W. MESSENT. *Norwich: H. W. Hunt*, 1936. $7\frac{1}{2} \times 5$ *inches; 298 pages; illustrations.* 7*s* 6*d*

The author has already written books on The Old Cottages and Farmhouses, and The Ruined Churches of Norfolk, The City Churches of Norwich, and The Monastic Remains of Norfolk and Suffolk. He is a worker in a rich field, for, as the title page states, the county has a thousand churches, 275 of which have gone to ruin. This is a useful book giving concise and trustworthy accounts of the important features of the churches in alphabetical order, much on the lines of Frederick Harrison's well-known 'Notes on Sussex Churches,' though not quite so handy for the pocket. More counties should follow this lead. In commendably clear type Mr. Messent gives the average archaeologist and motorist just what he wants on a visit to a church. Naturally Norwich Cathedral is outside his plan. The emphasis is on structure and architectural development, and it would be easy to find cases of omission of items of interest; but this would be ungracious. Wherever possible, the date of the beginning of Registers is given. No less than 129 round towers are listed as still standing. S. E. W.

THE MESOLITHIC SETTLEMENT OF NORTHERN EUROPE: A study of the food-gathering peoples of Northern Europe during the early post-glacial period. By J. G. D. CLARK. *Cambridge: University Press*, 1936. $10 \times 7\frac{1}{2}$ *inches;* xvi+284 *pages; illustrations and maps.* 25*s*

The object of this book is to give a general account of the Mesolithic cultures of northern Europe. The author describes clearly and adequately the material remains of these cultures, and their distribution in time and space. The book contains a good supply of maps and diagrams. Dr. Clark is not content however merely with technological description. He attempts to follow the changes of the geographical setting, and to show the relation of these to man's way of life. "The retreat of the ice-sheets, and the phenomena which followed in their train, form the physical background to the Mesolithic settlement of man in Northern Europe, and are therefore fundamental to a full understanding of the cultural developments of the period."

Chapter I, which is entitled "the Natural History of the Area of Settlement," reviews the evidence for geographical changes obtained from studies of raised beaches, submerged forests, clay varves, pollen analysis, etc. Though the author is perhaps a little too optimistic about the simplicity of the isostatic theory, he has provided a very useful summary of literature that should be helpful to the archaeologist. A useful correlation in tabular form is given on p. 53 between changes of sea-level, stages of forest succession, and cultural changes. Chapters II to V are devoted to descriptions of the various cultures—Kunda, Lyngby, Maglemose, Ertebølle, Tardenoisian and their local variants. In these chapters Dr. Clark not only describes the cultural and faunistic remains and

their distribution, but tries to deduce from these how the peoples actually lived. He has wisely, too, not neglected the suggestions which a knowledge of living cultures may make for the interpretation of archaeological material. He points out that the Maglemose culture was especially connected with low-lying sites near rivers, lakes, and fens—a fact which has been favourable to the preservation of their remains. Fishing and fowling were important, though mammalian remains are also plentiful. These Maglemose settlements were small and appear to have been inhabited only for part of the year. The condition of the roe-deer antlers points to summer occupation, and the abundance of broken hazel-nut shells to a stay into early autumn; but many of the sites are so low-lying that they could not have been occupied in a wet season. The author suggests that in winter the people may have moved away to the coasts (which are now submerged). It might be worth while in this connection to consider Dr. Gösta Berg's suggestion that skis and the runner-sledge go back to Ancylus times, and would enable hunters to make long journeys into the woods.

The Ertebølle culture, which is associated with the period of the Litorina Sea, showed the influence of forest conditions, as did the Maglemose culture out of which it evolved. Most of the sites were coastal ones and they appear to have been inhabited all the year round, a fact that possibly reflects the milder climate and a richer food-supply from the sea—shellfish, gulls, fish, etc.

In striking contrast with the Maglemose sites are those of the Tardenoisian culture, which are closely associated with either high ground or with sandy areas; this may account for the poverty of wood and bone remains. Such areas may have been comparatively free from forest; it is noticeable that the axe is normally lacking in the culture. On these infertile areas, the carriers of the Tardenoisian culture were not exposed to competition with newer peoples and cultures, and in some places they survived long after younger waves had flowed into richer districts.

The author gives a considerable amount of space to Maglemosian art and discusses its possible origins and connections. At the end of the book is a general summary, a number of appendices dealing with such things as faunal lists, lists of sites, etc., and a folding map that shows the distribution of the Maglemose culture.

This book is the result of a large amount of painstaking work. Dr. Clark has read widely and has presented his results clearly and concisely. He has given us a general survey of the Mesolithic cultures that should for some time to come form a useful framework into which we can fit new facts as they are discovered. The book can be strongly recommended. R. U. S.

IN THE HEART OF EUROPE: Life in Czechoslovakia. By GERALD DRUCE. *London: George Allen and Unwin*, 1936. 7½×5 *inches; 228 pages; illustrations and map.* 6*s*

We have here a good general guide for English visitors to Czechoslovakia who want to know something of the land and its peoples. The plural is used advisedly; for though we may now reckon Czechs and Slovaks as one nation, we are here shown minorities not only of other Slavs, the Ruthenians and Poles, but also of Germans (in more than one region), Hungarians, and Romanians—not to mention gipsies, now being induced to submit to education and cleanliness and a more settled mode of existence. Besides descriptions of the picturesque towns and varied countryside of this long strip of Central Europe, there are informative chapters on life in the capital, travel on the railways, amusements and sports, science, art, and religion, and what is perhaps the most astonishing feature of the country, the curative spas which, great and small, are said to

number over two hundred. The book has a good representative lot of illustrations, and there is the official 1/2 M map, with small plans of the environs of Praha, Brno, and Bratislava. J. H. R.

OVER TYROLESE HILLS. By F. S. SMYTHE. *London: Hodder and Stoughton*, 1936. 9×5½ *inches;* xvi+292 *pages; illustrations and map.* 12*s* 6*d*

This book is the record of a journey undertaken by Mr. Smythe with one companion from the Silvretta group to the Hohe Tauern. The district is not built by nature for sensational mountaineering feats, nor was it Mr. Smythe's object to search for or describe such adventures. The journey is a plain story of three weeks' wandering over hill, over dale, in which the author has conveyed to us a good measure of his own delight in the lesser mountain ranges.

Mr. Smythe has an easy gift of straightforward description, and his photographs are admirable, the subjects well chosen and in keeping with the character of the book. There is plenty of good company whether on the mountainside or at evening in the huts. While Mr. Smythe is afoot one is never dull. He has however a tendency to digression, it may be merely for a few guide-book statistics or for a longer discourse on international politics or the ethics of sunbathing. Somehow one does not feel inclined for moralizings on free trade and cosmic rhythm when toiling up a moraine, or to answer the author's countless rhetorical questions. He has a certain delicacy in the choice of words; let us hope that he will overcome his old reluctance to call a smell a smell, and his fondness for such archaisms as puzzlement and luminosity. Both text and index suffer from misprints. Whenever Mr. Smythe ventures into a foreign tongue there is trouble. One cannot well demand Gasthöfe for gasthofs, but the holiday mood is interrupted by many mistakes—as bon bouche, bon giorno, würst, abbatoir—unpleasing to a pedant's ear. Even the monarch of North Wales is rechristened to the honour of a distinguished political figure.

But Mr. Smythe has certainly written a most enjoyable book, and from the moment when he catches sight of the Alps between mouthfuls of salmon mayonnaise until we bid him good-bye at Zell am See, we can enter with gratitude into his enthusiasm for the simpler forms of mountain travel, and wish him good luck for his greater enterprises. H. E. G. T.

PORTUGAL: A book of folk-ways. By RODNEY GALLOP. *Cambridge: University Press*, 1936. 9×5½ *inches;* xvi+292 *pages; illustrations and sketch-map.* 15*s*

As its title indicates, this is a book with a double appeal: travellers and others in quest of information about Portugal will appreciate it as much as the student of folk lore, who is desirous of comparing the ways of the Portuguese with those of other European peoples. The author has a profound first-hand knowledge of the land, which he is able to impart without a trace of pedantry.

Mr. Gallop devotes the first fifty pages to a brief tour of Portugal which, despite the hint in the preface, few would be well advised to skip. Of the remainder of the book, more than one-half is occupied by five chapters dealing with traditional beliefs and customs, and this is the part which will appeal to the folklorist. There is much that is repugnant and something that is quaint in these survivals: few would fancy roast cat as a cure for asthma, but the story of the love-lorn ass, or the potion that went wrong, is a good one. Most interesting of all is the attempt to fit Portuguese customs into the framework of common European heritage. Thus we learn that the traditional battles between Christians and Moors can be related back to ritual battles between Summer and Winter; that Carnival (elsewhere a ladylike survival) in Lisbon yet retains some of the

bawdiness inherited from the Saturnalia; while the legend of Nostra Senhora da Merceana shows how the Church has laid its hands on the ancient cult of the oak tree and the bull, the emblems of the gods of Thunder and War.

The last five chapters deal with folk music and literature. That on the ballad is perhaps the weakest: the account of its historical development is not clear. The author is more successful when dealing with the popular quatrain. Of both quatrain and ballad numerous examples are given, accompanied by translations that are competent, if not outstanding. The peculiar quality of Portuguese poetry is well illustrated: *O canto é para os tristes, Quem o pode duvidar?* The chapter on folk tales and proverbs is sketchy, and suggests that Portugal cannot compete with Spain in this respect: the savour of Sancho Panza and Gracián is lacking. In the chapters on folk song and the *fado* there are ample transcriptions of popular tunes. The chapter on the fado and the discussion of its origins is one of the best in the book. If the folk cannot create, as the author is always at pains to insist, its genius for borrowing and compromise is well illustrated by a form which has united native rhythm to negro syncopation, and contains traces of the sophisticated cadences of Italian opera. To appreciate these "deliquescent and immoral melodies" is, according to some critics, to wallow in the "mire of crapulence."

Some mention must be made of the illustrations. The photographs are good, but the drawings by Marjorie Gallop impart final character to the book. There is a map in the form of end-papers, an index, and a bibliography (which might be better arranged). The book is virtually free from typographical errors.

J. P. H. M

ASIA

ANCIENT IRRIGATION WORKS IN CEYLON. Parts I, II, III. By R. L. BROHIER . . . under the direction of G. K. THORNHILL. *Colombo: Ceylon Government Press*, 1934–35. 13×8 *inches;* 37; iv+43; viii+77 *pages; illustrations and maps. Rs.* 3 each part

Mr. Brohier, whose ancestors settled in the island under the Dutch East India Company, is an officer of the Survey Department with an unusually extensive knowledge of the country, and as is to be expected deals with the geographical aspect of his subject in considerable detail; perhaps his most substantial contribution is his clear indication of the inter-relation which exists within groups of reservoirs and channels in particular localities. This is illustrated by a series of useful maps; on the other hand, in several instances topographical maps of his Department have been hurriedly adapted, and are not only full of unnecessary details but are extremely difficult to handle. For example, the last map but one in Part I, which is not mentioned in the list of maps, is on a sheet 40×24 inches, when the desired information could have been more satisfactorily conveyed on one a twentieth of that size. Some of the photographic reproductions are good; the descriptive notes attached to them might have been omitted without diminishing their interest. As pointed out in a brief Preface contributed by the Surveyor-General, under whose direction the work was prepared, no attempt has been made to deal with the engineering aspect of the subject; a great deal of space is devoted to the historical and archaeological side, but the writer's knowledge is seriously out of date. For instance, he identifies (i, 4–5) Pandavava with the earliest irrigation work mentioned in the Chronicles, whereas it has been conclusively shown by H. W. Codrington ("Topography of Mediaeval Ceylon," Jr. Ceylon Branch, R.A.S., vol. 29, 1922) that Pandavava is the Pandavapi of Parakrama Bahu I. Again, he seems to be

unaware that there were two Seas of Parakrama, constructed one before and one after that monarch became sole ruler of the island. When he connects Raja Kumara Wanni with Wijaya, he has forgotten the Raja Wanniya and Kumara Wanniya of comparatively recent times. His ignorance of the results of modern research among European archives is noteworthy, as where he twice ascribes to Bhuwaneka Bahu the date 1534–1542, thus shortening his reign by twenty-two years in all. A more intimate knowledge of existing Dutch maps would have been of assistance in dealing with the northern Vanni and Peninsula of Jaffna.

As a whole the work lacks system, and the historical notes and descriptions of reservoirs and channels consist of rambling accounts, largely extracts from previous writers, diaries, and other official documents—often of wearisome length and not all relevant—out of which it is not easy to glean any positive facts. Native names are not spelt according to any consistent method: *Ratta* for *Rata*, frequently repeated, is irritating. Several of the appendices—for instance two out of three in Part II—are reprinted from previous publications. It is not always that the temptation to indulge in fine writing has been resisted. The Glossary can be improved on: "an elderly Buddhist priest" is not an adequate explanation of Terunnanse, which connotes sacerdotal status. The proof reading has been inadequate: among names for instance appear "Ivers" for "Ievers"; Graffe for Graaf; Burnard for Burnand; Rebeiro for Ribeiro; Angelbeck for Angelbeek; Paulausz for Paulusz. An error in the Errata can hardly be excused—see the second item in the list of three in Part III, which apparently should be "for 1624 A.D. read 624 A.D."

The typography, size of page, and weight of each volume will not attract the reader; they are not compensated for by the striking brevity of most of the writer's paragraphs; Part I, page 19, contains twenty-four paragraphs of four lines or less each.

The work has been prepared on the orders of the Minister of Agriculture and Lands, who in a Foreword states that "This publication is intended to arouse and stimulate the interest of the people of this country in the wonderful achievements of their ancestors." It is not suited for the general reader; but Mr. Brohier is entitled to great credit for a laborious collection of miscellaneous traditions and facts, which will be of use on the shelf of a student. P. E. P.

THE NEW MONGOLIA. By LADISLAUS FORBATH, as related by JOSEPH GELETA. Translated from the Hungarian by LAWRENCE WOLFE. *London: William Heinemann*, 1936. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 276 pages; illustrations.* 15*s*

M. Forbath has compiled this book on Outer Mongolia from the recollections of Joseph Geleta, a Hungarian engineer who was engaged in varied activities there from 1920 to 1929. It gives very welcome information about incidents of daily life, especially in the capital, but a number of general statements must be qualified in the light of facts which emerge in other passages.

The first half of the book describes M. Geleta's journey, as an escaping prisoner of war, from Siberia *via* Uliassutai to Urga. The obscure introductory passages do not explain why, as late as 1920, an ex-combatant of the Great War had to "escape" from the Bolshevik power works where he was employed; in any case he felt free to visit the Siberian "headquarters of the Reds" in the following year (p. 169).

On reaching Urga, M. Geleta joined two White Russian ex-officers in setting up a "smoked sausage factory," then changed to the more congenial task of making crude mines for the Chinese Army. Nothing availed the Chinese however against the small but desperate force of Baron von Ungern-Sternberg, and M. Geleta gives a gruesome picture of the reign of terror which ensued.

The reader would better understand why the Mongols originally helped the Baron to power if M. Geleta had dealt as fully with the excesses of the preceding Chinese military régime, under General Hsü ("Chu" in the text, pp. 153–4).

After spending a short period at a Siberian border town, Troitskosavsk, where he maintained himself by smuggling, M. Geleta returned to Urga. By this time the Mongols, with liberal Soviet support, had defeated Ungern-Sternberg, and the new "National Government" sponsored progressive schemes. M. Geleta was commissioned to build a power works and a parliament house, which also served as a theatre. He speaks with obvious approval of the new Constitution, in which, he says, it is clearly established "that the inhabitants of Mongolia are free citizens, with complete freedom of speech and assembly. Every one who works enjoys complete equality with the rest of the nation, without distinction of nationality, race or creed" (p. 198). Lest the word "free" be interpreted in too broad a sense however it is well to note the difficulties encountered by those wishing to leave the country, or indeed the city of Urga. Describing his own preparations for departure in 1929, M. Geleta writes: "Had I been an ordinary Mongolian citizen, or a foreigner without connection with the State, I should have had to go to the police and prove my 'political trustworthiness' before being allowed to leave the capital" (p. 264). In addition to three rigorous customs examinations, travellers are stopped many times by frontier guards (pp. 266–274).

M. Geleta declares that the Mongols have been exploited by foreign traders (pp. 100, 191), but the comparison made on the dust-cover with the theme of the Russian film "Storm over Asia" is misleading. The "foreigners" to whom M. Geleta refers are Tsarist Russians, Chinese, Tibetans, Japanese, and, finally, Soviet Russians (pp. 211–221). France, Great Britain and the United States, even when the *Bogdo Gegen* offered them favourable trade agreements in order to weaken Russia, refused to be drawn into Mongolian affairs (p. 211).

The book closes with an account of M. Geleta's journey, in summer, along the well-known route from Urga to Kalgan. The "perils" of the journey lose nothing in the telling; it is recorded for instance that he and his fellow-passengers in the motor car suffered from "accelerated breathing" due to the fact that they "were travelling 6000 feet above sea-level" (p. 268), although their starting-point had been Urga (4785 feet), M. Geleta's home for seven years.

In conclusion, it is most regrettable that a book of this type should appear without a single map. An index would also have helped to link up the various historical summaries, which often run ahead of the narrative. Native words and proper names are spelt rather erratically, and it must be kept in mind that "c" is often used as in Hungarian, in place of the English "ts": *e.g.* "Cagan" (p. 68), "Cam" (p. 87), "Cecan" (opp. p. 118), "Ceren" (p. 196) "Co!" (p. 23), should be Tsagan, Tsam, Tsetsen, Tseren, Tso. The Soyots ("Saiodes" in the text) are not Mongols, as stated (pp. 1 ff), but of mixed origin, probably Tatarized Samoyeds.

E. J. L.

CAMBODIAN GLORY: The mystery of the deserted Khmer cities and their vanished splendour; and a description of life in Cambodia to-day. By H. W. PONDER. *London: Thornton Butterworth*, 1936. 9 × 5½ *inches; 320 pages; illustrations, sketch-maps, and plans.* 15*s*

In recent years several books on Angkor have appeared, and many writers have attempted to describe the indescribable. The chief importance of Miss Ponder's book lies not so much in her descriptions of Angkor and its monuments, good though they are, or in the narrative of her personal experiences in Cambodia, but in the seriousness with which she has approached the historical side of her

book. She has read the recognized authorities with diligence, and when she quotes from them she is careful to state her source; that is much, in days when authors of a certain type of travel book are too prone to use the work of others in the same fields with scant acknowledgment. The result is that Miss Ponder has produced a well-documented summary of Angkor's tangled history and chronology and an intelligent review of recent archaeological scholarship and conclusions, which hitherto have been difficult of access to the ordinary reader.

Miss Ponder does well to accord full credit to Henri Mouhot as the man who first revealed the existence of these extraordinary ruins to the world. Although Mouhot was not the first nineteenth-century European to visit them, or to describe them, it was he who possessed the vision and ability to convey to others something of the marvels he had seen. Fortified by the encouragement of the Royal Geographical Society, he set out in 1858 to explore the then almost unknown Indo-China peninsula. In the following year a letter from D. O. King and a paper on Dr. S. R. House's discoveries at Angkor were read at one of the Society's meetings, but little attention seems to have been paid to the ruins until the results of Mouhot's expedition, from which he did not return, were revealed. The modern tourist who to-day visits Angkor by motor car will do well to give a thought to this gallant traveller and artist whose enthusiasm first aroused European interest in what was soon recognized to be the most important archaeological find of the nineteenth century, and Miss Ponder is to be congratulated on having written a book which deals so comprehensively and so faithfully with the story of Angkor both before and since Henri Mouhot's visit.

O. R.

AFRICA

LAND WITHOUT SHADE. By HANS HELFRITZ. Translated from the German by KENNETH KIRKNESS. *London: Hurst and Blackett*, 1935. 9½×6 *inches; 288 pages; illustrations and sketch-maps.* 18*s*

It is a pity that in this book Dr. Helfritz has not done justice to his own journey. He is the first European to have followed the old caravan route from Hadhramaut to Yemen by way of Harib: he did this alone, with scanty knowledge of Arabic or of Arab psychology: and he emerged in safety, after many hardships and imprisonment, on the Red Sea coast; but to call himself "the first man to cross the southern part of the Rub' al Khali" is to spoil a good achievement by overstatement.

This fault, and many inaccuracies, spoil what should have been a valuable account of pioneering travel. To mention Aden as "a small island in the Indian Ocean" (p. 27) is misleading; as it is to call the Al Kaf "virtual rulers of Hadhramaut" or to suggest that a sea-borne slave trade is still carried on there as it is in the Red Sea. The Sayyids are not Badawin chiefs; the moon god's name is not Sense; and indeed some less irresponsible reading in South Arabian history would have enhanced the value of the book greatly.

The list of wild statements might be prolonged indefinitely: but Dr. Helfritz writes with freshness of things he has actually seen: the dancing, the feasts, the tribal gathering in Kor Saiban are experiences any traveller might envy; and the best part of the book is that which deals with his stay in unknown Harib and the everyday life of Yemen. The dangers in the Badawin parts are highly coloured, but the discomforts bear a stamp of truth and the photographs are the best (though not, as is asserted, the first) ever taken in the Hadhramaut. It is only regrettable that, among so many qualities that fit him for a traveller, the author attends so little to modesty of statement or carefulness of verification.

THE PARADISE OF FOOLS: An account, by a member of the party, of the expedition which covered 6,300 miles of the Libyan Desert by motor car in 1935. By MICHAEL H. MASON. *London: Hodder and Stoughton*, 1936. 9×6 *inches; 282 pages; illustrations and map.* 15*s*

In this volume Mr. Mason relates the experiences of himself and five valiant fellow-travellers (one of whom lost his life owing to a most unfortunate accident) during a motor-car journey of nearly three months in the Libyan Desert, in the course of which places as remote from each other as Mersa Matruh on the Mediterranean coast and El Fasher in Darfur were visited, various sites of archaeological interest discovered and examined, and much hitherto untrodden ground explored.

Mr. Mason has a talent for vivid description, as well as a sense of humour, and his narrative is so delightfully written that it is difficult to put the book down until one has reached the end. His impressions of the desert have all the charm of freshness (who but a new-comer into the region would have eaten the slice of colocynth-gourd of which he describes the effects on p. 49 ?), and what he has to tell us of the desert animals, with the collecting of which he chiefly concerned himself on the journey, is of particular interest.

It is perhaps inevitable that in a book of this kind there should occur one or two scientific inaccuracies. It is not for example the sand-blast, but alternations of intense heating by the sun in the daytime and rapid cooling by radiation at night, that shatters rocks in the desert (p. 233); nor can the slip-face of a sand-dune, the inclination of which to the horizontal never exceeds some 32°, be properly called a "precipice" (p. 238), although when looked down upon from the dune-crest it certainly presents the appearance of being much steeper than it is in reality; and according to the map in the book (on which, by the way, the degree-numbers of the meridians and parallels are omitted) the "westernmost point" mentioned on p. 70 was not by any means the most westerly point reached by the expedition, nor was it in longitude 27° E. But these errors scarcely detract from the general merit of the book, and a perusal of the volume may be cordially recommended to any one who is desirous of combining entertainment with the acquisition of a knowledge of what modern exploration in the Libyan Desert is like.

Three short appendices by two of Mr. Mason's fellow-travellers deal succinctly with the use and care of cars in the desert, the organization of rations, and the archaeological results obtained, while a fourth by himself consists of brief natural history notes. J. B.

UNKNOWN LIBERIA. By HARRY J. GREENWALL and ROLAND WILD. *London: Hutchinson & Co.*, 1936. 9½×6 *inches; 284 pages; illustrations.* 18*s*

'Unknown Liberia' is a hearty and straightforward description of the Republic of Liberia on the West Coast of Africa, as seen by two journalists whose point of view was that of "the man in the street" in England or America. There is little in it which is new, or news to the informed African traveller, or to those whose work lies in West Africa. The Liberian Government's pretensions to civilization have for long been a subject for jest throughout West Africa, and it has long been apparent that if certain other peoples in different parts of the world were "unable to stand by themselves" according to civilized standards, the emancipated oligarchy who are nominally responsible for the good government of some two million Africans whom they cannot control either morally or, for the most part, physically, fall far short of any standard which would qualify them to administer a Mandate over more backward peoples.

Europeans who live in Africa usually acquire a sentimental regard for the

institutions of Africa; and a respect and preference for those institutions, as against the surface veneer of civilization which was naturally more intelligible to the authors of this book. The book is for that reason the more interesting and perhaps instructive, for its values are not the values of the Administrator, Missionary, or Scholar, but those of Fleet Street. In fact it is a good example of how West Africa strikes an "untutored European." The descriptions of life in Liberia are accurate enough from the point of view of the journalist. They are unvarnished, and in places crude; but their minuteness and crudity, from the point of view of those familiar with Africa, are a measure of the profundity of the ignorance of the average American and British citizen of the real nature of the peoples and problems with which his Government deals.

There is a great deal which is both just and true in Chapter XI on Negro Nationalism, as for instance the following:

> It is our belief that the white man can make Liberia wealthy and happy and contented, but the question remains how these desirable ends should be attained. In order to attain them, should the Negro dream of a national home be crushed? . . . Killing Liberia would be to the Negro people like stamping on a small child's conception of Santa Claus. An independent Liberia can never be a threat to world peace, but for strategic and geographical reasons the collapse of Liberia might very easily be as much a threat to world peace as was the Abyssinian conflict. H. R. R.

DURBAN: Past and Present. Compiled and edited by ALLISTER MACMILLAN. *Durban: William Brown and Davis*, [1936]. 11 × 8 *inches;* 340 *pages; illustrations*

One-half of this volume about "beautiful Durban" consists of short accounts of the principal Durban business concerns; and presumably they were able to help considerably in overcoming the "peculiar difficulties inseparable from the specialized character of the labour involved" in the other half. Various writers have contributed such chapters as "The Dawn of Durban," "From Settlement to City," "From Sandbank to Super Port," etc. These are interspersed with short poems by the editor and compiler, and the whole is well produced and illustrated. J. P. H. M.

THE BIRDS OF TROPICAL WEST AFRICA, with special reference to those of the Gambia, Sierra Leone, the Gold Coast and Nigeria. By DAVID ARMITAGE BANNERMAN. [In six volumes.] Volume IV. *London: The Crown Agents for the Colonies*, 1936. 10½ × 7 *inches;* xl + 460 *pages; illustrations and map.* 22*s* 6*d*

The fourth volume of Mr. Bannerman's monumental work on the Birds of Tropical West Africa deserves notice in the *Geographical Journal*, if only for the publication of the new map of the Gambia on a scale of 1 : 5,000,000, which has been specially printed for this work through the co-operation of Colonel P. K. Bulnois. This map is far in advance of anything at present available to the public, and will be indispensable to every worker in any branch of science who may visit this region. This volume, the first on the great Order of the Passeriformes, incorporates the ornithological results of extensive travel by a large number of workers in little-known regions throughout tropical West Africa, far beyond the confines of the Gambia. It is profusely illustrated with fourteen coloured plates depicting 65 species by such well-known artists as George Lodge, Roland Green, Hendrik Grönvold, and the late Major Henry Jones. There are also 117 half-tone drawings and an "Illustrated Key," so that besides being essential to the systematist it is invaluable to the field naturalist,

the sections on field characteristics and distribution being particularly useful.

It is pleasant to find how numerous are the Government officials of various Departments who have contributed material to this volume. An interest in natural history is one of the greatest mental assets which a tropical administrator can possess, assuring him of relief and relaxation in surroundings of social isolation and amidst the physical trials of tropical service. This work is a god-send to such men.

ZAMBEZI DAYS. By WILFRID ROBERTSON. *London: Blackie and Son* (1936). $8 \times 5\frac{1}{2}$ *inches;* (iv) + 196 *pages; illustrations.* 5*s*

This is a light and interesting book about Rhodesia which gives a good description of life on the march. The whole is built up round one of the author's journeys in the Zambezi Valley, which serves to introduce numerous digressions and anecdotes. Thus the habits of the natives and of the animals besides the various trials and tribulations which beset a march through the bush, are all touched upon. Perhaps the most instructive chapter is that entitled "Arms and the Man," in which some wise advice is given on the choice and treatment of rifles. The author says "spare the rod and spoil the—rifle," and quotes the story of a friend who said of cleaning his rifle, "I can't make myself a slave to that sort of thing." The end of the story, and of the friend, is indeed sufficient to impress every reader with the foolhardiness of such a creed.

This book, like so many others written by those who live in the country, sounds a note of warning about the natives who have become semi-civilized more by accident, or rather contact, than by good teaching. Altogether it is a readable book which gives a good conception of life and some of its problems in the out-of-the-way parts of Rhodesia.

There are sixteen plates and no map, but the absence of the latter does not detract much from the interest of the book. V. E. F.

NORTH AMERICA

AN ILLUSTRATED MANUAL OF PACIFIC COAST TREES. By HOWARD E. MCMINN and EVELYN MAINO. With lists of trees recommended for various uses on the Pacific Coast; by H. W. SHEPHERD. *Berkeley, Calif.: University of California Press* (*London: Cambridge University Press*), 1935. 8×5 *inches;* xii + 410 *pages; illustrations and maps.* 16*s*

This volume contains an account of the trees, both native and exotic, which will flourish on the Pacific Coast of N. America. An introduction of twenty-seven pages gives general instructions on the naming of plants, including an explanation of botanical terms, and a brief survey of the distribution of Pacific Coast trees. This is followed by an artificial key to genera, based chiefly on leaf characters.

The main portion of the work consists of a descriptive list of the species, arranged according to Engler's System. Under each species are given the common names, a brief description, native locality, and notes on occurrence on the Pacific Coast. The great majority of the species are illustrated by excellent line drawings, and there are also many photographs of the growing trees. The pronunciation of Latin names is indicated by a grave or acute accent (representing long and short vowels), and the derivation of generic names is given. The accent on the first syllable of *Populus* is given as acute, whereas a long vowel would be classically correct, and there are a few other similar errors. Under *Parkinsonia* John Parkinson is referred to as "James"; but on the whole these useful features have been accurately carried out.

The book ends with a list of trees recommended for planting on the Pacific Coast, compiled by Professor H. W. Shepherd. This should be of use to horticulturists not only in N. America, but in other parts of the world with similar climate. The authors have written an attractive and scientifically accurate book, which will be welcomed by all those who are concerned with the identification of the woody vegetation of W.N. America. J. S. L. G.

THE BIRTH OF WESTERN CANADA: A history of the Riel Rebellions. By GEORGE F. G. STANLEY. *London: Longmans, Green and Co.*, 1936. 9×5½ *inches;* xiv+476 *pages; illustrations and maps.* 15*s*

From the title one would expect this book to treat of the story of the transition of the North-West from the jurisdiction of the Hudson's Bay Company to that of the Dominion of Canada. Something is said of this, but nothing of the filling of the West with settlers. It is rather the story of the two rebellions, that of 1869–70 and that of 1885. What strikes one most perhaps is the extraordinary incompetency of the Government at Ottawa. Instead of taking the advice of the man on the spot, this was persistently ignored. Had the Government even made clear that the titles of the half-breeds would be respected, half the principal cause of unrest would have been removed. When surveys were made for the meridian the Indians imagined a fresh survey was being made of their lots. To Orange Ontario the difficulty seemed merely that raised by some Roman Catholic half-breeds against the Protestant English. Riel, who had the Church with him, should have set off for Ottawa. Instead he caused Scott to be murdered and alienated many of his followers.

The second half of this volume gives a very full account indeed of the Indian Rebellion on the Saskatchewan. The author has studied his sources very thoroughly, but is apt at times to quote rather fully from the originals. This shows at any rate how deeply he has studied these. One or two have been neglected and he would no doubt have done well to study Adam Begg's *Journal* and the files of the *Nor'Wester*.

This is the first time that this subject has been treated in anything like an adequate manner, and the author, who was a Rhodes scholar, deserves very great credit for giving such a complete survey of these events. He has tried to hold the scales evenly, but has perhaps not always emphasized sufficiently the real causes of the revolts nor the bad blunders committed by the Government, although he has shown how they refused to take proper heed of the warnings of the men on the spot.

The effect of these events has lasted till recent times. Quebec, formerly Conservative, became a stronghold of Liberalism and has remained so until this year. Ontario never really grasped the true inwardness of what was taking place on the Saskatchewan, but merely backed up the forces of public order. This was all to the good, but had proper measures been taken at the outset the half-breeds would never have been driven to revolt. The final chapter on the political results is one of the best in this well-written volume, the fruit of much hard work on the part of the writer. Students of the history of the West will be grateful to Dr. Stanley for his labours and for having presented to the reader such a vivid account of the troubles of 1870 and 1885. H. P. B.

STEEL OF EMPIRE: The romantic history of the Canadian Pacific . . . By JOHN MURRAY GIBBON. *London: Rich and Cowan*, 1935. 9½×6½ *inches;* 424 *pages; illustrations and maps.* 21*s*

This volume, 'Steel of Empire,' describes the foundation, construction, and operation of the Canadian Pacific Railway. Mr. Gibbon delves deeply and

perhaps at too great length into the early history of Canada for the student who from a general knowledge of Canadian historical background is seeking particular information on the development of the Canadian Railway system; and yet, having regard to the imperial significance of the C.P.R., which is far wider than the territories served by its railway system, it is understandable that the edifice of the book should be erected on wide foundations. An over-abundance of illustrations is less excusable, as they can but provoke adverse comment on the lack of discrimination in their selection. The author would seem to have been too close to his task to have exercised a proper sense of proportion.

The author has exposed himself to criticism by his continuous praise of all that the C.P.R. has done or has left undone. To this extent the book marches out of time with men of the calibre of Strathcona, Mount Stephen, Van Horne, and those who have followed in their footsteps, whose greatness can well withstand a critical survey of the limits of their accomplishment and of their foresight.

The problem of the Canadian Railways looms very large on the horizon of Canadian politics, and through 'Steel of Empire' one gains an admirable approach to the viewpoint of those who advocate the private control of railway systems. The wonderful story of the building of the C.P.R., of the struggle of private enterprise to attain an imperial end and then to retain it, is told with graphic detail, and Mr. Gibbon is to be congratulated on the wealth of action and colour captured within his pages.

The last spike of the trans-continental railway was driven on 7 November 1885 by Donald Smith (Lord Strathcona) on the summit of Eagle Pass, British Columbia. "Asked to make a speech, Van Horne said: 'All I can say is that the work has been well done in every way'—then the conductor called 'All aboard for the Pacific,' and the simple ceremony was over."

The student of Dominion history cannot ignore this volume, and much of it he will value.

AMERIKANISCHE LANDSCHAFT: Entstehung und Entwicklung in Einzelbildern. Edited by ERICH VON DRYGALSKI. Ozarkland, by RUDOLF SCHOTTENLOHER. Kanadische Prärie, by MAX EICHMEIER. Florida, by PETER BERGER. Jamaica, by A. WILHELM KÜCHLER. Seattle, by HOMER L. SEEGER. *Berlin: Walter de Gruyter & Co.*, 1936. 11×8 *inches;* viii+532 *pages; illustrations and maps. M.*26

It is over thirty years since von Drygalski returned from the German South-Polar Expedition (1901–1903). Since then he has continued to influence the trend of geographical research from his post as Professor in the University of Munich. From some eighty student dissertations submitted during this period he has selected five by his most recent disciples and bound them together in a handsome bulky volume bearing a somewhat misleading title, which the qualifying sub-title only partially excuses.

The five sections of the volume deal with Ozarkland, the Canadian prairie, Florida, Jamaica and Seattle. No unity of argument or treatment is attempted, the five studies having in common only the facts that they deal with the New World and that they were inspired by the distinguished editor's participation in the Transcontinental Expedition of the American Geographical Society in 1912. Despite its format and title therefore, the book can be appraised only as a group of entirely unrelated studies on geographical subjects, treated with characteristic German attention to detail, fully documented—the Ozark bibliography alone lists 400 titles!—controlled however in all cases except the Canadian prairieland by the particular writer's familiarity with the area he describes. As

such, they stand the test better than the majority of geographical dissertations.

(1) R. Schottenloher devotes the bulk of his 125 pages to a geomorphological analysis of the Ozark Highlands, illustrating it with excellent photographs, three serviceable double-page maps (bound so as to open clear of the book), and several diagrammatic text-maps that leave something to be desired in the matter of clarity and finish. The most interesting part of the study is a 24-page discussion of the relationship of the highlands to the interior plains of North America in respect of climate, vegetation, and settlement. From three points of view the Ozarks form a frontier salient on the zone of contact between (*a*) continental-polar and maritime-tropical climatic forces; (*b*) prairie and woodland ecological conditions; and (*c*) settled and pioneer social developments. The third of these aspects is treated under the title "In the current of the new civilization," and gives a readable résumé of the history of the settlement of the area. An instructive diagram based on U.S. census data is used to show the self-sufficiency and agricultural independence of the Ozark "island."

(2) Max Eichmeier's treatment of the Canadian Prairie is based entirely on a study of existing literature and will be of value primarily to students in Germany who have no access to such standard sources as the Canada Year Book.

(3) The first seventy pages of Peter Berger's study of the Florida peninsula are given to a detailed discussion of land-forms, climate, soil, and vegetation, illustrated by some useful diagrams and maps summarizing data much of which is culled from such not easily available sources as the publications of the Florida State Geological Survey. These form the basis for a subdivision of Fenneman's recognized physiographic sections of the peninsula into fourteen main geomorphic districts with minor subdistricts. The photographs and diagram maps are well chosen and form a valuable feature of the paper which gives the best conspectus of the variety of geographical elements in the peninsula that I have yet seen.

(4) A. W. Küchler's treatment of Jamaica covers a wider range of aspects than the other studies, allotting sections to geological structure, climate, physiography, vegetation, fauna, agriculture, settlement, racial elements, industry, politics, and status in the British Commonwealth. Having lived on a plantation for a number of years, the author writes as an insider and gives a well-balanced, if occasionally superficial, summary characterized by a familiarity with the background of life on this "trade-wind island." Among the more instructive passages is one discussing the agricultural adjustments after the slump caused by the abolition of slavery in 1834.

(5) The section on Seattle is by an American, Homer L. Seeger, who traces the development of the city from its birth as a final outpost of the pioneering "Drive to the West," through the second stage of its growth as a port for Alaskan and Pacific trade, to its third expansion under post-war influences. The illuminating tables of trade statistics are a lesson in themselves and attest the mushroom growth of the city. To a student of urban development dealing with a city of nearly 400,000 inhabitants there must be an unquestionable satisfaction in the knowledge that eighty years previously there was a population of one individual dwelling in a district of primeval forest! In the decade between 1880 and 1890 its population rose from 3500 to 42,000. The study may be commended as a clear-cut statement of city evolution in a case where the various factors can be isolated with exceptional ease, unhampered by the conditioning constraint of an older history.

G. B. B.

AUSTRALASIA AND PACIFIC

STONE-AGE BUSHMEN OF TO-DAY: Life and adventure among a tribe of savages in North-Western Australia. By J. R. B. Love. *London and Glasgow: Blackie & Son* (1936). $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xxvi+220 *pages; illustrations and sketch-map.* 8*s* 6*d*

Mr. Love worked for forty years amongst the Worora, an aboriginal tribe who occupy the coastal region in the north-west of Australia, and established his Mission Station not far from Port George the Fourth. The author gives an interesting account of his early experiences and adventures whilst winning the confidence of a people who were, and to some extent still are, in the Stone Age. He also relates his difficulties with the language, which looks as if it belongs to the Indo-Polynesian group. The book is mainly concerned with the customs of the Worora, but whereas the author never goes very deeply into any of the ethnological points which he mentions, his long experience of the people, combined with a sympathetic attitude towards their outlook and institutions, except when these offend a sense of justice or are quite incompatible with Christian morality, has enabled him to produce a book which, whilst it is interesting as a record of missionary work, is also of value to students, because it gives a good foundation for the study of the cultural background and the economic conditions in which the natives live.

This is to say that whilst the general reading public will find much information to interest them, the more specialist reader too will find the book of considerable interest, and one hopes it may stimulate some one to make a study of these people and answer the questions to which, apparently, the author has not yet been able to find an answer. One is left wondering for example why men should have a form of burial different from that accorded to women, whilst a dog has a more pretentious funeral than that of a woman. Further, it is not unusual for men to kiss their dogs (and, presumably, their wives), but the author has never seen a man kissing his child.

The author makes two observations with regard to the manufacture of stone spearheads, which are of importance to those concerned with Prehistoric cultures. He says: "Yet all this highly skilled labour is for one throw of the spear. The stone points are very brittle, and consequently break when thrown, unless the spear should pierce a soft part of a beast and be retrieved unbroken. More often than not the point is broken off in the kangaroo. . . ." And also: "All the men make good spearheads. I cannot name any man who cannot make a good one though some are even neater than others." The tools for making spearheads are illustrated.

The chapter on Messages and Messengers is full of interest; he disposes of the myth that the Australian aborigines in his area can send messages by smoke signals, or by "bush telegraph," the facts being that smoke is used to a limited degree as a signal, and that messages travel extremely rapidly because of the endurance of the native messenger, in precisely the same way as news travels with almost incredible speed in many parts of Africa. E. B. H.

AND FAR FROM HOME. By T. E. A. Healy. *London: Michael Joseph* (1936). $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 256 *pages; illustrations.* 12*s* 6*d*

The first half of the book deals with the experiences of the author in Western and North-Western Australia. The author, a journalist, finding himself out of a job and extremely short of cash, makes his way to Broome and relates his adventures in producing a newspaper there. He gives a vivid and fascinating account of the pearl divers operating in Broome and of the great perils and attendant loss of life which accompanies their every-day occupation.

In the second half of the book the author describes his experiences as Special Correspondent at Port Darwin during the Mildenhall–Melbourne Air Race, which are of historical interest. But he also has a good deal to say about the aboriginals, the work done by the Missions, and the problems which face those responsible for law and order in the country.

Mr. Healy writes with a freshness and a vigour of style and language which, combined with a sense of humour, have produced a book full of human interest. Whilst it is true that the book may be correctly described as popular, on the other hand, the author has his serious moments, and when he deals with the problems of native administration and justice he touches on subjects which are of interest to all students of cultural contacts and colonial administration.

E. B. H.

AGRICULTURAL ORGANIZATION IN NEW ZEALAND: A survey of land utilization, farm organization, finance and marketing. By H. BELSHAW, D. O. WILLIAMS, F. B. STEPHENS, E. J. FAWCETT and H. R. RODWELL. (Institute of Pacific Relations, International Research Series.) *Melbourne: University Press, for New Zealand I.P.R.—London: Oxford University Press*, 1936. 9½×6 *inches;* xx+818 *pages; maps.* 21*s*

New Zealand is one of the "youngest" of the "new" countries. Four years have yet to pass before the centenary of the planting of the first organized colony in the country, but few countries have experienced such rapid development or such sweeping changes in the aims and methods and output of their agricultural industries. Very broadly three main eras may be distinguished. Up to the introduction of refrigeration in 1882 progress was primarily in the direction of extending occupation, particularly on the natural grasslands of the South Island, and primarily with a view to increasing the output of wool from the fine-woolled sheep flocks. The second main era lasted till the Great War. Refrigeration had added meat and dairy products to the staple exports of the country, and expansion of production, especially of these newer exports, had gone on with astonishing rapidity, largely, but by no means wholly, by bringing new land into use. This expansion was more marked in the North Island than in the South, in the forest lands than in the natural grasslands, in dairying than in sheep-rearing, but everywhere it was characteristic. It involved the discovery and application of a new technique both in bringing forest land (often hilly) into use, and in pasture and animal management when the forest had been successfully replaced by grass. A feature of organization was the rise of co-operation to supremacy in the manufacture of butter and cheese. The third era, consisting essentially of the post-war period, has seen dairying still further increase its relative importance; lamb displace mutton as the characteristic type of meat export of the country; aggregate production, especially of meat and dairy produce, continue to grow. The trend to intensification in appropriate areas is indicated by decreasing size of average and typical holding, and by the adoption of improved methods of farm management. The result has been the attainment of an output-per-acre capacity quite comparable with that of the farm lands of the Old World, but achieved by what is relatively a skeleton labour force. Characteristic of this period has been the increase of research work by Government institutions and other bodies. The stimulus lay ultimately in the price situation with its effects on land values, and the increasing weight of such fixed charges as mortgage indebtedness was suddenly and disastrously accentuated by the onset of the depression in 1931, which not merely brought immediate distress but disclosed the insecurity of the economic basis on which the whole economy of New Zealand was built.

The time was ripe, then, for a searching investigation into the agricultural industries of the country in all their aspects—geographical, historical, technical, financial, and economic—and this is the task which Professor Belshaw and his large team of experts have essayed. The result is a very imposing volume, comprising thirty-six chapters and over eight hundred pages, which will stand as a model of co-operative research systematically planned and thoroughly executed. It corresponds exactly to the contemporaneous "Canadian Frontiers of Settlement" series, but the more limited scope of the New Zealand work has permitted more exhaustive treatment of the common problems. To workers in New Zealand it will, as the editor suggests, serve as a jumping-off point for further research in many directions, but for a long time to come it will not be superseded as the standard reference work on the agricultural industries of New Zealand. Every bit of it is relevant to a study of the economic geography of the Dominion, but geographers will perhaps extend a special welcome to such chapters as "Geological Structure and Topography," by Professor W. N. Benson, "Soils of New Zealand," by Mr. B. C. Aston, "Climate," by Dr. E. Kidson, "Pastures of New Zealand," by Mr. E. Bruce Levy, "Sheep Farming" and "Dairy Farming," by Mr. E. J. Fawcett. A minor criticism concerns the sketch-maps: the smallness of the scale prevents them from giving full value for the very considerable amount of labour that must have gone into their compilation, and the draughtsmanship is not above reproach, but as a whole the work represents a major achievement in the history of social and agricultural research in New Zealand. R. O. B.

CARTOGRAPHY

ORBIS ARCTOI NOVA ET ACCURATA DELINEATIO, auctore Andrea Bureo Sueco 1626. Edited by HERMAN RICHTER, in collaboration with WILHELM NORLIND. (Publications from the Geographical Institute of the University of Lund. Treatises. III.) *Lund: C. W. K. Gleerups Förlag*, 1936. *Text:* 12×9 *inches;* xxii+49 *pages;* 8 *maps. Atlas:* 24×18½ *inches;* 6 *sheets*

The publication of a full-size reproduction of this historic and beautiful map has been financed by the South Scandinavian Geographical Society. Although seven copies of the original have now been discovered, it has hitherto been known chiefly by reputation, and its description as a *rikskarta* has led more than one writer, including the present reviewer ("Early Maps of Scandinavia," *Geogr. J.*, July, 1927), to believe that it represented Sweden only. Actually it covers the whole of Scandinavia, Finland, Courland, Livonia, Lithuania, and the south coast of the Baltic.

It is a magnificent map, finely engraved and adorned with a large cartouche in Flemish sixteenth-century style, portraits of King Gustavus Adolphus and his queen Eleonora, coats of arms, ships, sea-monsters, Neptunes, compass-roses, and in the north with many engravings of reindeers, Lapps, hunters, and the like, which show the influence of Olaus Magnus's *Carta marina* of 1539. The projection is conical, the scale approximately 1 : 1,000,000. The longitude is based on the meridian of Corvo, but the peninsula of Norway and Sweden is made too broad, although it is shown as covering almost the same number of degrees and minutes of longitude as it does in reality. Bure cannot therefore have plotted his longitude from his prime meridian, especially as the Equator was then reckoned to be shorter than it is, but from the exaggerated length which Ptolemy had given the Mediterranean. The engraver was Valentin Staffanson Trauthman.

The memoir, in English, which accompanies the map is illustrated by reproductions of eight of the most important maps which preceded Bure's. Some of these are very useful, but others, unfortunately, are not very legible. With these the editors might have dealt more fully in their text. Mercator's Europe of 1554, for instance, is worthy of note as showing by far the best representation of Scandinavia of the time, based as it was on Ziegler's *Schondia*, Magnus's *Carta Marina*, and Anthoniszoon's *Caerte van Oostlant* (all reproduced here); and in their brief reference to Marcus Jorden the editors do not mention that his map of Denmark became widely known through its adoption, with minor alterations, by both Ortelius and Rumold Mercator in their atlases.

The memoir is valuable for its full account of the beginnings and the methods of large-scale surveys in Sweden towards the end of the sixteenth century, which were made necessary by the disputes over frontiers with Denmark in the north-west and Russia in the north-east, and by the activities of the Danes in having plans made of the towns of Skåne, and were facilitated by astronomical determination of the latitude and longitude of many places in the north, under the influence of Tycho Brahe. His methods were followed by Anders Bure and his brothers Johan and Olof, who between 1599 and 1605 traversed and surveyed much of Sweden and made plans of several towns around the Gulf of Bothnia. In 1603 Anders Bure was charged by Charles IX to make a map of the northern regions, and in consequence he drew a map of northern Sweden, then rather debatable land, which was engraved in 1611 (reproduced here), and the present map in 1626. As the editors point out, he must have taken the Dutchman Adriaen Veen's *Nativus Sueciae adiacentiumque regnorum typus* (1613) as a model, for the two maps cover the same area and have many resemblances. Bure improved the topography of Sweden very much, but Veen's configuration of southern Sweden is better. Although the editors do not mention it, Bure adopted Mercator's version of Jorden's Denmark for his map, and for Norway was largely indebted to a map of 1617 by W. Blaeu. The editors believe that he was helped materially by his brothers and by Daniel Hjort in his delineation of Sweden.

In dealing with the later editions and influence of the map the editors describe a new revised edition published by Hondius in 1635. We have never seen a copy of this, and it would seem to be very rare. Actually however Bure's work was made known to the world in the 1633 (German) edition of the Mercator-Hondius atlas, where it appeared in a much reduced form. For the next forty years it constantly reappeared in Dutch and French atlases. Nor do the editors seem to have noticed that two portions of the map, *Uplandia* and *Livonia*, were published as separate provincial maps in Blaeu's atlas of 1641, beside a *Gothia* which was not Bure's, and no less than six sections of it (*Nordlandia*, *Uplandia*, *Sveonia*, *Livonia*, *Finlandia*, and *Lapponia*) in Blaeu's atlas of 1662. All of these were on a slightly larger scale than that of the original, and in all the longitudes were drastically altered. The Blaeus obtained formal permission to publish Bure's map in 1649. It is just possible that these provincial maps were one of the results of Bure's appointment in 1628 as organizer of an official Swedish land-survey; but they are copied from the large map.

The editors give the full history of the copper plates, of the slight variants in the seven known copies of the map and of its earlier reproduction, in ten copies only, in 1866. The second half of the memoir contains the descriptive Latin text which Christoffer Reussner published in Stockholm to accompany the map, with an English translation. While much of this is historical, it contains a good deal of information about products and trade. The topographical notes show how closely Bure and his assistants had surveyed the wild and sparsely

populated districts of northern Sweden and Finland before they drew a map which was indeed worthy of being dedicated to Sweden's great king, Gustavus Adolphus. E. L.

GEODETIC OPERATIONS IN THE UNITED STATES, Jan. 1st, 1933 to Dec. 31st, 1935. By WILLIAM BOWIE. Special publication No. 207. Issued by Division of Geodesy, U.S. Coast and Geodetic Survey, Washington. *Washington: Government Printing Office*, 1936. 12 × 10 *inches; 25 pages*

Here is a very brief account of gigantic geodetic activity. In the lean years 1933–5 survey work in the British Empire continued at a reduced rate, resulting from recent retrenchment. Simultaneously exactly the opposite occurred in the U.S.A. There emergency funds were allotted and geodetic work had about a million pounds available for the three years 1933–5. Why this difference? Dr. Bowie writes:

> It has been possible to secure these emergency funds for the geodetic surveying because of the widespread interest shown in the results of the triangulation and levelling by engineers, planners and others throughout the country. It is realized that a knowledge of position, distance, direction, and elevation is needed for almost all classes of engineering work. Such data are absolutely essential for making accurate maps and in the establishment and location of national boundaries and boundaries between subdivisions of the country.

The truth of the facts underlying the last two sentences is not limited to the area of the U.S.A.; but unfortunately its importance appears to be recognized only there. The great increase in amount of funds made available has enabled the U.S.C. & G.S. to double the length of its chains of geodetic triangulation (to 67,000 miles) and to quadruple the length of precise levelling (to 261,000 miles). One has only to glance at the two charts showing these activities to realize the revolutionary change in the position now compared with that of 1932. Of course there are other developments too. Thus forty-seven first-order base-lines were measured, gravity measurements were continued, and other scientific inquiries advanced.

All this is in keeping with the plan to finish the topographic mapping of the country in ten years. Probably only surveyors will appreciate the immensity of this programme; but a very much larger number of persons will reap its benefits, which are of a national character.

The organization of this vast and rapid expansion must have called for great energy and sound judgment on the part of Dr. Bowie. The education of public opinion (*vide* first sentence of excerpt above) must also be attributed to him and his permanent staff—a veritable team of apostles!

In recent years the Division of Geodesy has been issuing a quarterly "Geodetic Letter." In this one finds technical points, as well as more human questions which affect the field worker, written about by the very men who are concerned with them. Then there are appreciations from outside sources of work done by the department. The circulation of the Geodetic Letter is not confined to the department but reaches many outside countries. No doubt by its means useful practical information is disseminated and at the same time interest is whetted. A humble member of the survey may derive much satisfaction from a small, but public, appreciation of his efforts; and others may strive for a similar recognition. The Geodetic Letter will widen the views of individuals of the personnel and increase their pride in their work. J. DE G. H.

ECONOMIC AND HISTORICAL GEOGRAPHY

WORLD IMMIGRATION, with special reference to the United States. By MAURICE R. DAVIE. *New York (and London): The Macmillan Company*, 1936. 8½×5½ *inches;* x+588 *pages; map and diagrams.* 16*s*

This volume, as its sub-title states, is written with special reference to the United States. As in a publication by Fairchild, issued before the War, the work concerns itself with the sociological effects of the segregation of large colonies of nationalities in areas of the United States. In order to aid the reader there are long, and *ad hoc* quotations, to illustrate the argument, taken from newspapers and works of fiction as well as from text-books. The first portion of the volume deals with the sources of American population drawn from European countries and deals first with the twenty-four million people that have left the British Isles. It is clearly demonstrated how the Middle States soon in the Colonial Period became the home of many nationalities, despite the shocking conditions of transport in the trans-Atlantic ferry service. The detailed statistical analysis of the immigration commences with arguments based on the 1790 Census. Incidentally the author is incorrect in saying that only the Domesday Book and the Swedish Census of 1749 pre-date this United States Census, for in 1750 and 1755 the Scottish Church under the Moderatorship of A. Webster made a parochial enumeration of the people in Scotland.

It is significant that a long chapter has been devoted to the Asiatic immigration into all parts of the world, and that this chapter should precede the chapter on United States Immigration Policy. The author is convinced that the days of free immigration are at an end for the white as well as the coloured settler. After consideration of the movements of people into the British Empire the volume concludes with a long statement as to the ability of the United States to assimilate the settlers into the life of the country, whether the agent of "Americanization" be the public schools or marriage or the desire to have the political status of a citizen. The volume is extremely well supplied with bibliographical references, and all that need be said in conclusion is that read in conjunction with certain of the maps in the Atlas of the Historical Geography of the United States, edited by Paullin, it gives a clear picture of the movements of people that have helped to build up the United States' population so rapidly. A. C. O.

LE PÉTROLE ET SON ÉCONOMIE. By various authors. Preface by LOUIS PINEAU. *Paris: La Librairie Technique et Economique*, 1935. 10½×7 *inches;* 220 *pages; illustrations and maps.* 30 *fr.*

It has been said that the twentieth century is the age of petroleum. This is not because man derives his chief source of mechanical power from oil (coal still does and is likely to continue to do the bulk of the world's work), but because oil is the fuel which has made possible, through the internal combustion engine, the more striking advances in the technique of transport which are so characteristic of the present century. On land, sea, and in the air, the motor car, the Diesel engine and the aeroplane have revolutionized modern transport in a comparatively short space of time. These technical developments have forced a rapid expansion of the oil industry itself.

Students of economic geography as well as business men find it difficult to keep in touch with the rapid growth of the oil industry. From this standpoint the book under review is of value. It attempts, with a considerable measure of success, a survey of the development of the industry in recent years up to 1934, from the standpoints of statistics, organization, production, transport, and marketing. Written by a series of experts, it lacks, particularly in the cases of

the chief producing countries, uniformity of treatment, but it is packed with useful facts unobtainable elsewhere, as far as the writer is aware, within the covers of a single book Diagrams and sketch-maps are numerous and valuable, though here again lack of uniformity in the content of the sketch-maps robs them of some of their value for comparative purposes.

In the last chapter estimates of reserves and forecasts of future production are considered. The many difficulties involved in making estimates and forecasts for this industry are rightly emphasized: the uncertainty as to the values to be attached to the numerous factors involved is clearly pointed out: and the impossibility of predicting the extent to which the discovery of new and the expansion of existing oilfields may nullify present forecasts is justly stressed. It would seem that oil experts, as the result of many past failures, have at last learned a lesson the elements of which are inherent in the very nature of the geological conditions existing where oil is found. P. W. B.

GENERAL

ISLES OF THE SEVEN SEAS. By COLLINGWOOD INGRAM. *London: Hutchinson* (1936). $9\frac{1}{2} \times 6$ *inches;* 284 *pages; illustrations and sketch-map on end-papers.* 18*s*

The islands in question are Tahiti and Bora-Bora, Coll, Teneriffe, Sumatra, Dassen, Kyushu, Sanday, New Zealand, Little Tobago, Corsica, and Ouessant, which were visited by the author for a variety of reasons, chiefly botanical and ornithological. Mr. Ingram writes pleasantly, and although the book is composed of selections from his private diaries (of which only short extracts have appeared elsewhere), the style and form suggest careful editing. His admitted appreciation of the value of words does not always prevent the occurrence of phrases such as "avine population" (for "birds"), nor the substitution of "lations" for "lashings." Fellow-naturalists will appreciate the description of birds and plants. With human beings Mr. Ingram is less successful. There is an amusing portrayal of Armistice Day in Bora-Bora, and of a Scotch Minister in Coll, but generally the author does not feel for the natives of these islands the sympathy that he displays for their birds and plants. With regard to his note on p. 101, the coin is more usually called after the female of the species.

J. P. H. M.

GEOGRAPHIC DISARMAMENT: A study of regional demilitarization. By Major-General J. H. MARSHALL-CORNWALL. Published under the auspices of the Royal Institute of International Affairs. *London: Oxford University Press,* 1935. $9 \times 5\frac{1}{2}$ *inches;* xii+208 *pages; map.* 12*s* 6*d*

The author employs the term "geographic disarmament" to signify "the restriction or prohibition of armaments and armed forces in certain definite territorial areas." His study covers a much wider ground than might be realized from its title, or even from this definition. The absence of any time limit from the latter allows him to consider for example the history of armistice zones, just as the insertion of "restriction" permits a discussion of buffer states. The important portion of his work deals however with what is best described as regional disarmament or demilitarization, having as its object "to prevent the outbreak of hostilities." He shows that before attempts were made to establish this conception in international relations the alternative of "neutralization" was tried; in his view this has failed as a remedy, though it is arguable that the factors which have caused its failure in the past might prove equally fatal to schemes of regional demilitarisation.

The range of his book is wide, and the examples he quotes are drawn from all ages and continents, but he has naturally concentrated upon the post-war period, examining in particular the Versailles and Lausanne settlements. The two concluding chapters summarize past experience and discuss the future. To obviate the risk of frontier clashes he proposes the adoption of the principle of the zonal frontier, within which no military establishments would be permitted, the essence of the scheme being reciprocity, *i.e.* demilitarization on both sides of the frontier. The demilitarization of a zone on one side alone will continue only so long as the power whose sovereignty is thus limited derives some benefit from it or feels itself too weak to abolish it. Once however such a mutual zone can be established, its advantages will in time commend it to both parties. It is significant that in the most successful example of frontier demilitarization, the United States–Canada boundary, the original agreement applied only to the demilitarization of the Great Lakes; its application to the much longer land frontier was by tacit consent, and rests upon no treaty stipulation. G. R. C.

A COMMERCIAL GEOGRAPHY. By L. DUDLEY STAMP. *London: Longmans, Green and Co.*, 1936. $8 \times 5\frac{1}{2}$ *inches;* viii + 460 *pages; maps and diagrams.* 6*s*

According to the publishers this book is "intended for the general reader, for those preparing for such professional examinations as the Institute of Bankers, and for the upper forms of Secondary Schools." Dr. Dudley Stamp has therefore set himself the difficult task of catering for the general reader and for more specialized groups within the circle of the general reading public. In this dual task he has on the whole succeeded admirably, for he has written a clear and succinct account of the commercial geography of the world with special emphasis on environmental factors. His claim that geography is a key subject because of "the interdependence of all parts of the modern world" is a just one. Those who read this book will realize more clearly that interdependence; that in itself is no small gain in an age of economic nationalism.

The first ten chapters of the book deal with general aspects of the subject: Environments, Commodities, Power, etc. Then follow sixteen chapters on the different countries. The work concludes with a chapter on Trade Routes and a collection of specimen examination questions. The more important countries are all treated on a uniform plan under such headings as Position and Size, Physical Factors, Occupation of the People, etc. More space is given to the United Kingdom than to any other country. It is perhaps natural that this should be so in a book which is clearly destined to assist future bankers in their examinations, but is it a just proportion, in a general survey, to allot as much space to the United Kingdom as to France, Germany, Italy, Belgium, and Holland all together? It is interesting to compare the diagrams (p. 153) of the size, population, and wealth of the chief countries with the amount of space Dr. Dudley Stamp allots to these countries. The relationship is not always very obvious. The numerous diagrams and maps are clear and up to date.

T. S. W.

ELEMENTS OF GEOGRAPHY. By VERNOR C. FINCH and GLENN T. TREWARTHA. *London: McGraw-Hill Publishing Co.*, 1936. 9×6 *inches;* x + 782 *pages; illustrations and maps.* 24*s*

This substantial text-book of nearly 800 pages has been written for the first year of a college or university course in geography, and covers what is usually referred to in Britain as "general world geography" as opposed to regional geography. It is interesting as emphasizing the wide difference of approach to the

University study of geography in America and Britain. There is less emphasis on the geological background; historical geology finds little part, though physiographic processes are well treated; and a greater emphasis on climate. On p. 155 the statement that the "Köppen system has been so widely adopted that it is almost a world standard" prepares one for the exclusive use of this scheme. The Herbertsonian system finds no mention either in the text or the bibliography. Yet the authors realize that Köppen's scheme breaks down when applied to south-eastern Asia, and introduce modifications, including the dropping of Köppen's major type Cw. As a result, their map of climatic regions resembles Herbertson's scheme more closely than it does Köppen's, and unfortunately reintroduces one of Herbertson's most serious errors—the grouping together in one type of China, south-eastern United States, and the three regions of eastern Australia, Natal and the La Plata–Brazilian coastlands. The treatment of the climatic regions occupies a substantial part of the book—pp. 154 to 270—and a certain amount of repetition results from the equally full treatment of the major natural regions on pp. 662 to 752. Between the two sections is a valuable and novel one on the elements of material culture. The whole book is well illustrated and produced; a valuable series of world maps is given in an end pocket; many major advances in science receive notice, and each important chapter has a good bibliography. The price is reasonable and there can only be one regret: the absence of those comparatively small though fundamental modifications which would make this an acceptable text-book for use in Britain.

L. D. S.

THE COMPLETE BOOK OF SKI-ING. By F. HALLBERG and H. MÜCKENBRÜNN. (English translation by BRIAN LUNN from the 4th French edition.) *London: Edward Arnold & Co.*, 1936. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 318 *pages; illustrations.* 12*s* 6*d*

Ski have not been used very much on English expeditions except as an alternative to snowshoes. When L. R. Wager's party in East Greenland took ski during a summer journey amongst the coastal mountains few of the party were experienced skiers. Nevertheless the ordinary touring pattern ski showed themselves to be of great value, and there is no doubt but that they could be used more and used better. The present book would be of help to any party planning to take ski. The choice of ski, bindings and waxes are well dealt with, though the range of waxes is restricted to the Scandinavian makes. The description of technique is just analytical enough to satisfy a scientist and is excellently illustrated by diagrams which show the distribution of the skier's weight. The chapters describing walking, running, braking, turning, and minor jumping are useful and intelligible. The Telemark is relegated to its proper position as a turn in deep snow where there is plenty of room. In describing the Christianias too little attention seems to be given to the unloading of the ski by falling into the crouching position from the erect; and the instructions for the inside Christiania, or scissor turn, lack a necessary warning as to the very dangerous manoeuvre it can be.

As a whole the book has that wandering style one is accustomed to find in translations. But it contains some lovely photographs and even the chapters on racing, especially on cross-country racing, have their application to expedition problems. The only omission to a complete book of ski-ing is an account of summer ski, the short type, readily transportable, which might with advantage be tried in the Himalaya. An expert discussion of the merits and disadvantages of these would have been interesting and valuable.

M. A. S.

THE MONTHLY RECORD

EARLY MAPS OF SCOTLAND

In the *Journal* for August 1935 a short note was printed on a volume published in connection with the Jubilee of the Royal Scottish Geographical Society, entitled the "Early Maps of Scotland." It is gratifying evidence of the interest in this subject to record the appearance of a second edition within two years, revised and very considerably enlarged. The volume, to which several plates have been added, is published by the Society at 10*s.* 6*d.* (8*s.* to Fellows). Additions have been made to all the original sections, and several new features have been introduced, including a list of road maps and itineraries, and a useful bibliography. The lists of charts, geological maps, and railway maps have also been so enlarged as to be virtually new contributions. By widening the point of view, the cartography of Scotland has been brought into relation with the history of the subject in general. The list of early small-scale maps now includes all the important maps of Great Britain. Reference is made to a lost map of Scotland, *c.* 1550, made by John Elder, which is said to have formed part of the basis of Mercator's map of the British Isles of 1564, though, as is pointed out, Nowell's MS. map of 1574 in the British Museum suggests that a map of Scotland was then in existence which may have served as a common source for both Nowell and Elder. It may be that Elder, Lily, and Mercator were all utilizing material furnished by Alexander Lindsay, the pilot of James V's voyage to the Northern and Western Isles. The clear statement of the relationship between the various Dutch map-publishing houses will be of value to students.

KHAIRPUR STATE, SIND

We have received from Mr. M. B. Pithawalla a monograph upon the 'Khairpur State—a post-barrage investigation' (Karachi, 1935). Khairpur, the only native state in Sind, lies to the east of the Indus, just below the Sukkur barrage. The author has assembled a considerable amount of information from scattered sources bearing upon its physiography, climate, and economic development, and provided a number of sketch-maps and diagrams. The latter, in some instances, might have been clearer. The main features of the area are the eastern portion of the Indus valley, largely composed of alluvium deposited by the river, a section of the Great Indian Desert to the east, and the Ghar hills of eocene limestones. The first area, the zone of agriculture and population, is in constant danger of flooding by the Indus, which here flows above the level of the surrounding country. Khairpur, in common with Sind, has considerable extremes of temperature and a scanty and irregular rainfall: irrigation is therefore of primary importance as the sole source of water apart from the "kunds," or small accumulations of rain water, and the fresh-water lakes formed by percolation from the bed of the Indus. An old system of water-channels is in existence, drawing off the flood waters of the Indus, but it is rather haphazard in lay-out.

The building of the Sukkur barrage has altered conditions considerably. The largest of the barrage canals, the Rohri, passes through the state, and others have been built to supply local requirements. Though these advances have undoubtedly assisted agriculture, good wheat is now grown, and the prospects for an improved quality of cotton are favourable, there has been in certain areas a rise in the ground water-level through seepage from the canals, especially the Rohri, which has resulted in waterlogged fields and abandoned villages. Cultivable land has also been ruined by seepage and evaporation bringing

salts to the surface. It is suggested that leaching out the salts and deeper ploughing might do away with the "kalar" tracts, and pumping has been introduced to free the waterlogged lands. The writer believes that a broad remedy would be to reduce the difference between the Rohri canal and the neighbouring lands. It is also hoped that in course of time the canals will deposit sufficient silt to render their beds impervious.

GRAVITY MEASUREMENTS IN EAST AFRICA

Speaking of Africa "geological opinion is divided on many points, and especially on the origin and history of the Rift Valleys." The reasonable expectation that a gravity survey of Eastern Equatorial Africa would help to clarify the situation led the Department of Geodesy and Geophysics at Cambridge to formulate a scheme for its execution. Financial support was given by the Royal Society Government Grant Committee, the University of Cambridge, the Royal Geographical Society, and the Leverhulme Trustees. A report on the work accomplished is published in the *Philosophical Transactions* of the Royal Society (Ser. A., vol. 235 (1936) 445–531). Dr. and Mrs. E. C. Bullard left Cambridge in October 1933 with the necessary outfit and reached Mombasa on November 17. They toured in a locally purchased lorry through parts of Kenya, Uganda, the Anglo-Egyptian Sudan, the Belgian Congo, and Tanganyika Territory, occupying fifty-seven gravity stations and fourteen magnetic stations, and returned to Mombasa on 30 March 1934. The return to England was made by way of Cape Town, and there also gravity observations were made. From the point of view of gravity Africa in 1933 was still a "dark continent." In former German East Africa observations had been made by Professor Kohlschütter in 1899–1900 at some thirty-four stations, and these with a few coastal stations were all that had been done.

Dr. Bullard's paper is divided into two main parts: I, Measurements; II, Interpretation of results. The first refers principally to his own measurements, but the second is based not only on these but also on those of Kohlschütter. The party was in Central Africa for under four and a half months, and averaged three stations per week. A precision of one or two parts in a million was sought and in the main achieved, at least relatively. For such speed and precision one novel procedure, due to Dr. Bullard, was introduced which has much to commend it. This involved observations of pendulums at a base station (Cambridge) simultaneous with those at the field station, with simultaneous reception of such Morse radio signals as were emitted from Rugby. At both base and field stations those signals close to a prearranged time were registered photographically on a chronograph sheet, on which were also records of the pendulum flashes and the clock seconds. After identification of the same fragment of morse on both sheets an identical time datum on both sheets was secured. It was then a simple matter to find how much the field pendulum had gained or lost on the base pendulum; and thence the difference of gravity at the two stations. The only demand on the chronometer is that it should direct the observer to start his chronograph record at a suitable time.

There are of course still many sources of possible error. These are fully considered in the publication and the amount of the resulting probable errors carefully assessed. The total *a priori* probable error is sufficiently small, and the results have justified the deduction. The greatest source of uncertainty in the reduced value of gravity is that due to the height of the station. To obtain a value of gravity correct to one part in a million it is necessary to know the station height correct to 3 metres; and in an unmapped or partially mapped country this presents a problem of great difficulty. So far as the stations lie in

sufficient proximity to railway lines, where spirit-levelling of reasonable accuracy has been effected, all is well. In some other cases recourse may be had to triangulated heights; but where these too are not available differential aneroid readings must be resorted to. The height determinations have been classified A, B, C, unlikely to be in error by more than 5, 10, 20 metres respectively; and it is fortunate that only seven stations fall in class C.

Professor Kohlschütter in 1899–1900 had the same problem in a more aggravated form, as height data were scantier then; he met it most successfully with careful boiling-point heights. The heights of five of his stations have been re-estimated with fuller data and the disaccordance ranges between 9 and −12 metres. His gravity results have been checked at three stations and differ from Bullard's by 5, 6, 7 milligals respectively—an almost constant difference. This support of Kohlschütter's work justifies its use with Bullard's for the application to geological problems.

In Part II the observed values of gravity at all stations of Bullard and Kohlschütter are reduced to sea-level and on several hypotheses for correction for topography and compensation. The differences from the formula values of gravity are the anomalies. Unfortunately the old Helmert (1901) is used instead of the International formula adopted at Stockholm in 1930, in which the equatorial value of "g" is greater by 0·019 gals. (= cm. per sec. per sec.).

The mean anomalies of the eighty-nine station (Helmert's formula) are found as follows (in milligals):

Free Air	*Bouguer*	*Hayford*	*Heiskanen*			
		(113·7 km.)	40	60	80	100 km.
12	−124	−8	−3	−11	−18	−24

These quantities require a correction of −19 in relation to the International gravity formula, 1930. The mean departure from perfect compensation on the Hayford hypothesis is accordingly −27, which is a significant amount for an area of some half million square miles.

Whereas the Hayford anomalies are in general small, in five sections of the Rift Valleys they are markedly negative. (This is even more the case if they are reckoned from the International formula.) The conclusion for such cases is reached that there is a marked deficiency of matter under the rifts. This well-established fact is the main basis for discussion of the manner of rift formation. A suggestion of Wegener (1922) that rifts result from tension in the crust followed by fracture is mentioned, and dismissed as conflicting with the established deficiency of matter in some rifts; but the argument against tension as a possible cause is not convincing to the writer. An alternative theory of rift compression, suggested by Wayland, is developed and the conclusion is reached that this accords with the observed gravity anomalies. Additional support for this theory is given by the reversed rivers of Western Uganda. Difficulty however arises in explaining in a similar way some cases where rifts exhibit positive gravity anomalies, for example the Red Sea.

Whatever may be the final explanation of the formation of each and every rift, the gravity observations discussed in Bullard's paper provide important information regarding the underlying distribution of density. The Cambridge Department of Geodesy is to be congratulated on initiating the work and Dr. Bullard on its prompt and accurate execution. J. DE G. H.

WATER SUPPLY IN THE WHEAT BELT AND KALGOORLIE REGIONS, WEST AUSTRALIA

Mr. E. deC. Clarke, in his presidential address to the Royal Society of Western Australia, reviewed the question of water-supply in the Kalgoorlie and Wheat

Belt regions and its relation to their development (*Journal*, 22, 1935–36, pp. xi–xliv). In the Wheat Belt region, the plateau area of Mediterranean climate, a supply adequate for early requirements was provided by natural basins in the granitic rocks, but these disappear farther east in the Kalgoorlie region, the surface of the plateau being broken by low hills of metamorphic rocks which do not hold water well; hence in the early days of the gold boom the various methods of transport of water and condensation of saline supplies from the "lakes." This lack was finally overcome by the Mundaring 'weir' on the Helena river in the Darling range, from which water is pumped 350 miles to Kalgoorlie. An extension of this is now in progress to Norseman 100 miles south of Coolgardie. During the year 1934–35, 900 million gallons were supplied from this source; of this total, 340 millions were distributed in the area west of Southern Cross, *i.e.* largely to agriculturalists, and 352 millions to railways and the mines of Kalgoorlie and Boulder.

Recent developments in the Wheat Belt have made it imperative to increase water supplies and to distribute them more widely. A flour-importing country until 1905, Western Australia in 1929 exported wheat to the value of nearly £7 million. The collapse of world prices in the following year led to the growth of the sheep industry, which is even more dependent upon water. These needs are being met by reticulation from the Mundaring pipe-line, by which 1,000,000 acres are supplied; by District water supplies, that is reticulation from rock-catchments, which serve 700,000 acres; by wells and tanks, and, in drought, by rail transport. In the Kalgoorlie region, where the granitic catchment basins are absent, the ground water is too saline even for sheep raising.

Mr. Clarke then discusses the topographical, climatic, and geological influences on water supply over the whole area, as a guide to future development. Hope of tapping artesian supplies in any appreciable quantities has now been abandoned. In the wheat belt, the "reliable" winter rains and the catchment rocks already discussed render the problem less acute. The importance of conserving "roof" supplies is also stressed. For the lower areas, and for the pastoral industry, the solution lies in the development of earth catchments. The difficulties are obvious, particularly salinity of the soil and loss by evaporation. A scheme for killing the vegetation by crude oil and coating the bottom with bitumen is said to have yielded encouraging results. The high capital outlay of covering over earth catchments is a further obstacle to their full use. Wells on the higher areas may tap supplies of fresh ground water, but these tend to become saline.

The paper is well illustrated, and has six sketch-maps showing the extension of the area under wheat from 1888 to 1931.

LADY JULIA PERCY ISLAND, WESTERN VICTORIA

Professor F. W. Jones describes in *Nature* (28 November 1936) the work of the McCoy Society's expedition in 1935 to Lady Julia Percy Island, off the coast of western Victoria. This small uninhabited island, a plateau $1\frac{1}{4}$ miles long and $\frac{3}{4}$ mile wide, has several features of interest. Unlike the numerous islands off the shores of southern Australia, it is volcanic, never having formed part of the mainland, and no land molluscs, slugs or amphibia are found upon it. The only earth-worm is not an Australian species, but was introduced from Europe, and the only mammals are the swarms of introduced rabbits. Sea lions resort to the island, but it is curious that they are of a local and resident species, differing profoundly in behaviour and anatomically from the other species of the Great Australian Bight. Among the sea birds are the Bass Straits shearwaters and the whale birds, or prions; these are seasonal breeding visitors. There are

also penguins in thousands. A hundred years ago the island was covered by a thick mixed bushy scrub: this has now been completely destroyed by fishermen in search of fuel and by the rabbits, so that the present cover is of bracken and thistle only. Attempts have been made to exploit the island, but it is at present uninhabited. The expedition carried out a complete ecological survey of the island.

SOIL DRIFT IN SOUTH AUSTRALIA

A report by Mr. F. N. Ratcliffe, "Soil Drift in the Arid Pastoral Areas of South Australia," is published as Pamphlet No. 64 (1936) by the Commonwealth Council for Scientific and Industrial Research. This investigation was limited to those arid pastoral areas of South Australia which receive an average annual rainfall of less than 10 inches and are devoted almost exclusively to sheep. There are two main types of vegetation—"saltbush shrub steppe" (the "bush") and "acacia semi-desert scrub" (mulga scrub). Erosion by wind in these areas, much more important than that by water, has occurred mainly in the bush country where over-stocking, rather than rabbits or drought, has removed the protective plant cover. Though the process of dry erosion and the movement of wind-blown sand are natural phenomena in arid regions, their effects are generally counterbalanced by the growth of vegetation and the formation of soil. The occupation of the dry regions by man however has disturbed this balance, so that graziers are now faced with the problem of accelerated erosion and large-scale drift. This is shown to be due to disregard of correct stocking, which is always in equilibrium with the vegetation. Erosion and drift are symptoms of injudicious stocking.

Periodical droughts are a normal feature of the Australian climate, and provision for them must be made if the heavy over-stocking which they temporarily produce is not to have a cumulative effect on the value and stability of the land. The persistent nature of many of the fodder plants in the pastoral areas ensures that feed will be available for many months after the end of a favourable season provided the country is not made to carry too many sheep. Conservatively stocked properties in the saltbush country can successfully withstand short droughts and even prolonged ones with cautious management. The author exposes the fallacy of supposing that botanists, by discovering plants which can grow on drifting sand and denuded tracts, can provide a substitute for the adjustment of stocking to a sound basis. Such plants could only be established and spread if protected from sheep at critical times. The problem besetting the sheep farmers of South Australia is a special aspect only of a wider problem. Thus in "permanent" grass country over-stocking results in the gradual disappearance of the more valuable and palatable species, while less valuable species begin to play the part of noxious weeds. In this way the nutritious Mitchell grass is vanishing from the Queensland plains.

The author expresses the hope that Government action, which has already commenced, will be effective in preventing the progressive deterioration of the South Australian pastures. He refers to the misery caused by dust and drifting sand in the inland towns of the Broken Hill mining district. Much of this drifting is localized and might be arrested. The report is illustrated by a number of striking photographs. The sands in the neighbourhood of Lake Torrens present very much the appearance of great snow drifts.

ORIGIN OF SUBMARINE TROUGHS

In a paper by the late Professor J. W. Gregory on a submarine trough near the Strait of Gibraltar published in the *Geogr. J.*, March 1932, reference was

made to a theory of the glacial origin of such troughs by Mr. E. P. Shepard. Mr. Shepard has been investigating this problem recently, and gives a summary of his conclusions in the *Proceedings* of the National Academy of Sciences, 22 (1936) 496–502. He rejects the theories of their origin advanced by the late W. M. Davis and R. A. Daly. The data he has collected emphasizes the close resemblance between these canyons and river canyons on land. They cannot be accounted for by current action, as many are cut in hard rock, and currents in the open sea are generally held to be relatively feeble. It is therefore necessary to account for the exposure of these surfaces to subaerial erosion. He rejects the theory that these marginal areas have been uplifted, the canyons cut, and the areas then depressed, as these areas are too universal and occur off stable as well as off sinking and rising coasts; nor does he think it possible to assume a sinking of the ocean basins as the cause of the withdrawal of the water. He suggests that they are due to the "formation of enormous ice caps on the land which would allow the cutting of valleys on the sea floor to the extent that the sea-level had been lowered." To lower the sea-level 3000 feet would require large Polar ice-caps 4 miles thick; this he thinks is compatible with present physical and meteorological evidence. The sequence of events would then be: formation of depressions on continental slopes by landslides in part diastrophic and submerged true canyons; lowering of sea-level and flow of rivers into existing depressions, cutting canyons through recent sediments into the deep outer depressions; rise of sea-level and maintenance of canyons on the steep slopes due to mud flows.

ICELANDIC-DANISH EXPEDITIONS TO VATNAJÖKULL

Dr. Niels Nielsen, secretary of the Danish Royal Geographical Society, publishes in the *Geografisk Tidsskrift* for December 1936 an outline of some of the results of the recent joint Icelandic-Danish expeditions led by him to Vatnajökull in Iceland. In 1936 the scene of the volcanic eruption under the ice of the jökull was again visited, as the 1934 expedition had come back with negative results. A special study was made of those anomalous formations in the geology of Iceland which have puzzled former workers, especially the so-called Palagonite formation, where various deposits containing a special basaltic glass have been hardened. Dr. Nielsen's work has been to distinguish between various types of sedimentary and plutonic formations containing this material. The majority he ascribes to the Quaternary, especially to interglacial periods during which conditions in Iceland were very much as at present. In those conditions solifluction took place on a large scale and caused the agglomerations which are otherwise difficult to explain.

An interesting result of the study of volcanic eruption under ice was to find that pillow-lava is a typical feature of this activity. He expresses the opinion that the eruptions which are most powerful in the sense of available energy are the least productive in material; that an eruption which can melt 10 cubic kilometres of ice and then for a month throw a column of steam and ashes 12,000 metres into the air, as in 1934, is unlikely to produce much lava, and that when the lava-flow is considerable the capacity to melt ice, etc., is restricted.

MEETINGS: SESSION 1936–37

Third Evening Meeting, 30 November 1936. The President in the Chair

Elections: Cyril Edgar Adie; Vishnu Balwant Athavale, M.SC.; R. D. Baker; Tom Whittingham Brown; Augustus A. L. Caesar; James Edmund Cameron; Vice-Admiral Gordon Campbell, V.C., D.S.O.; Rao Sahib C. M. Ramachandran Chettiar; Field-Marshal Sir Philip Chetwode, G.C.B., K.C.M.G., D.S.O.; Walter Edmund Collins; Arthur Robert Colville; Robert Blackhall Connell; Raymond Arthur Cook; Miss Edith Corry; Miss Lily M. Cunningham, B.SC.; George Percy Hercules Davidson; David Carder-Davies, F.R.A.S.; Stephen Walter Denny; Professor Edward Charles Dodds, M.V.O., D.SC., PH.D., M.D., B.S., F.R.C.P.; Charles Robinson Doeg; Wilfrid Thomas Eardley Duncan; Miss Dorothy Fetherstonhaugh; Henry Eustace Tylston Hodgson; John Innes, B.SC., M.I.E.E.; Maurice Plevins Latter, F.G.S., A.I.M.M.; Commander Edward H. Longsdon, R.N.; Sir Leonard Lyle, Bart., J.P.; Mrs. C. E. Evelyn McCubbin; The Reverend Archibald MacKinnon; Miss Helen Isabel McSwiney; Lawrence W. C. Maidment, B.SC.; Miss Elsie Peel-Mears, F.Z.S.; John Clark Milne; Albert Mitchell; Andrew Park Mitchell; Miss Kate Leonora Wynne Morgan, B.A.; Thomas Stanley Lane Fox Pitt; Mrs. Henry Ravenscroft; Percy Read; Roland L. Redmond; Philip Ridsdale; George Schwab; Flight-Lieut. Cautley Nasmyth Shaw; Lieut. J. P. Stewart, R.N.R.; Miss Lucy Marion Taylor; Richard Caistor Treweeks; Henry Arthur Dalrymple-White; Gordon Whittle; Wing-Commander Ernest Leslie Howard-Williams, M.C.; Miss Marion Zimmerman

Paper: A Recent Flight across Antarctica. By Mr. Lincoln Ellsworth

Fourth Evening Meeting, 14 December 1936. The President in the Chair

Elections: E. G. Bindloss; Archibald Niel Black; Miss Evelyn Louise Burford; Reverend David Calder, B.A.; Alan Cawley, B.SC., A.R.S.M.; Francis Henry Colson; Eugene P. de Bellard, M.D., B.A.; Mrs. Eckersley; Lincoln Ellsworth; Cyril J. Evans; Roy Stafford Gobey; Charles Stephen Goodsman; Mrs. Florence Harvey; Miss M. E. Head; William Tyndall Henry; Ralph Hope; Group Captain Gilbert Stuart Martin Insall, V.C., M.C., R.A.F.; Captain J. C. Johnson; Carl T. Keller; Mrs. Edith Marion Helen Mason; John Farquhar Maxfield; Joseph Perrott; Miss Lillian F. Plunkett, B.SC.; Oscar Charles Raphael; Charles Ellison Rich; Sir George Roberts, Bart.; Miss Winifred Eileen Saville, B.A.; Reverend James Taplin; Captain Charles Arthur Taylor; Miss Gertrude Eleanor Thompson; Clifford White

Paper: The Mongol Landscape and People. By Mr. Owen Lattimore

Third Afternoon Meeting, 7 December 1936. The President in the Chair

Paper: Coral Islands of the Great Barrier Reefs. By Mr. J. A. Steers

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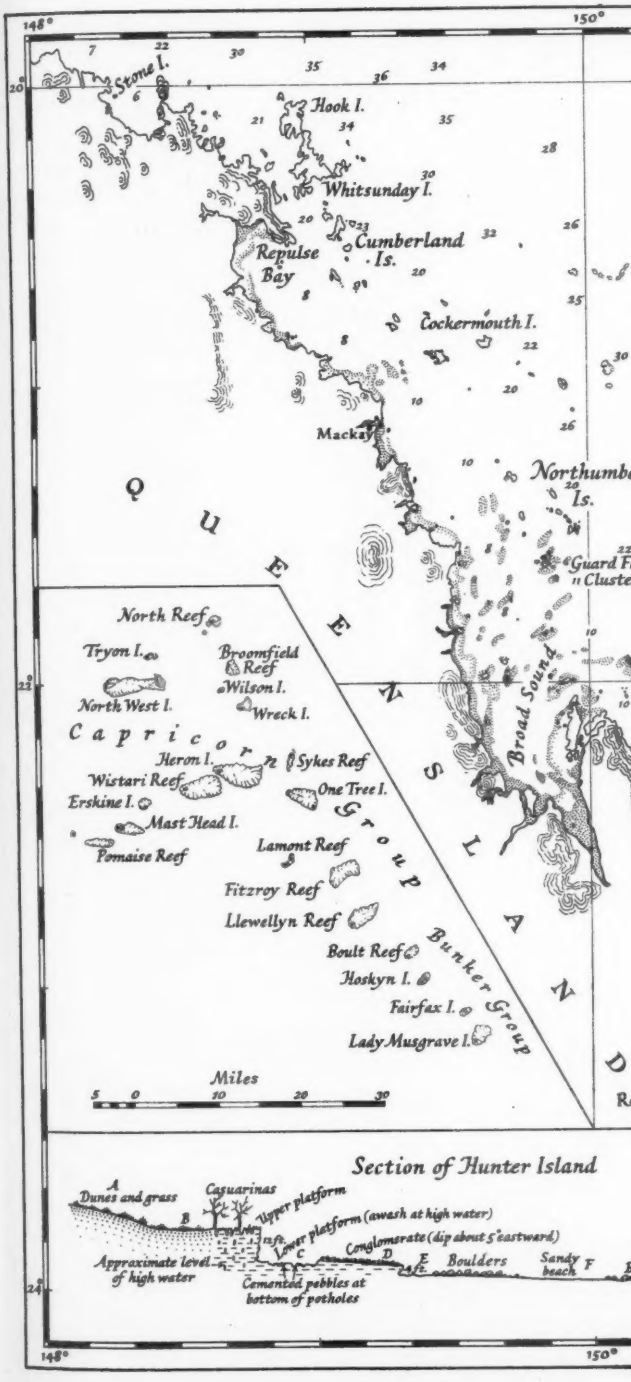
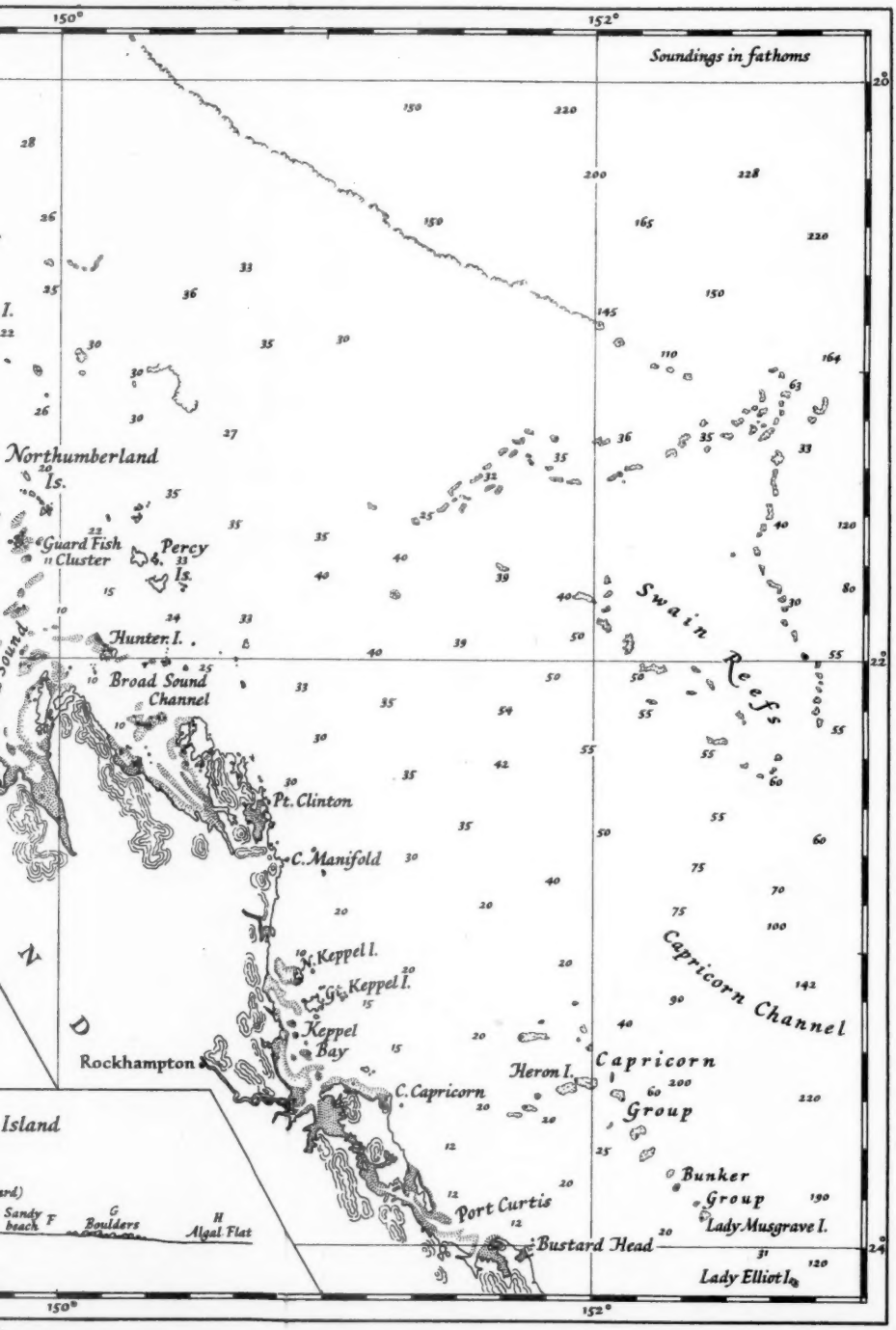


ND COAST AND ADJACENT REEFS
from Admiralty Charts



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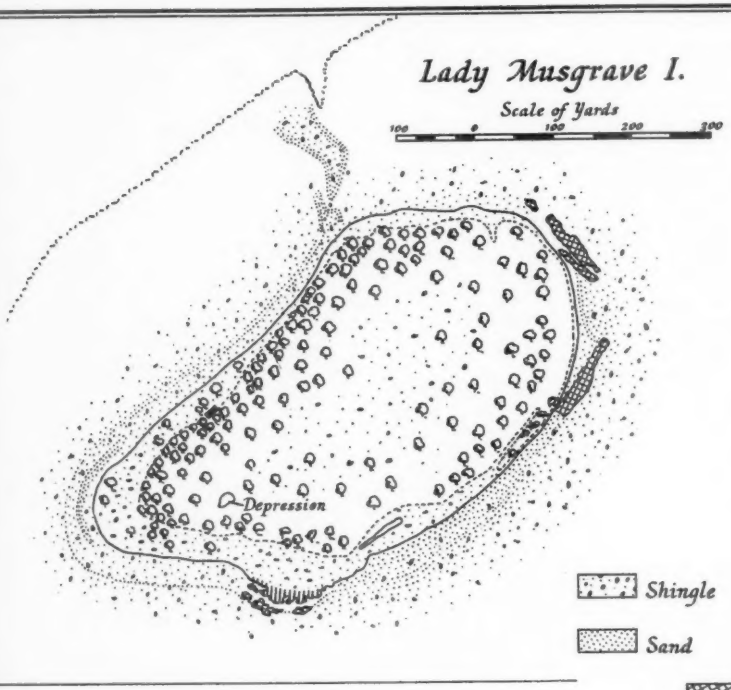
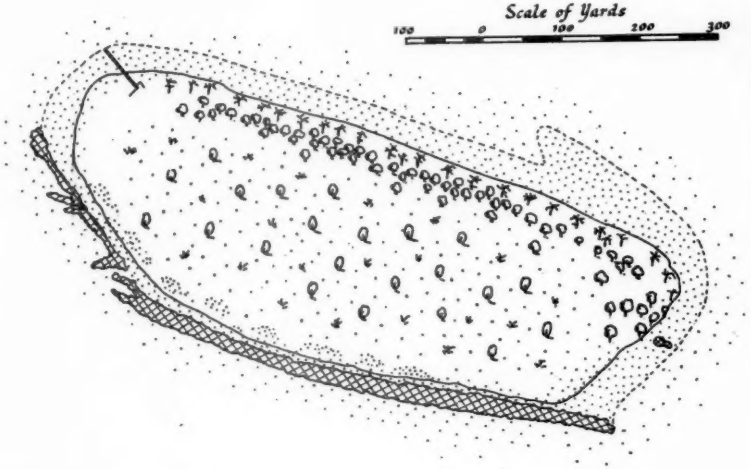

Lady Musgrave I.
Scale of Yards
100 0 100 200 300
Depression
Shingle
Sand

Stone I.
South Head
Raised beach
Old cliff
Sinclair Head
Coral & sand
Shoal Water Bay
Fragments of raised beach conglomerate etc.
Raised platform of coral conglomerate
Heavy shingle on raised spit
Raised beach
Old cliff
Dead coral reef (Hedley)
Scale of Yards
200 0 400 800 1200 1600

cal Society

Heron I.

Scale of Yards
100 0 100 200 300



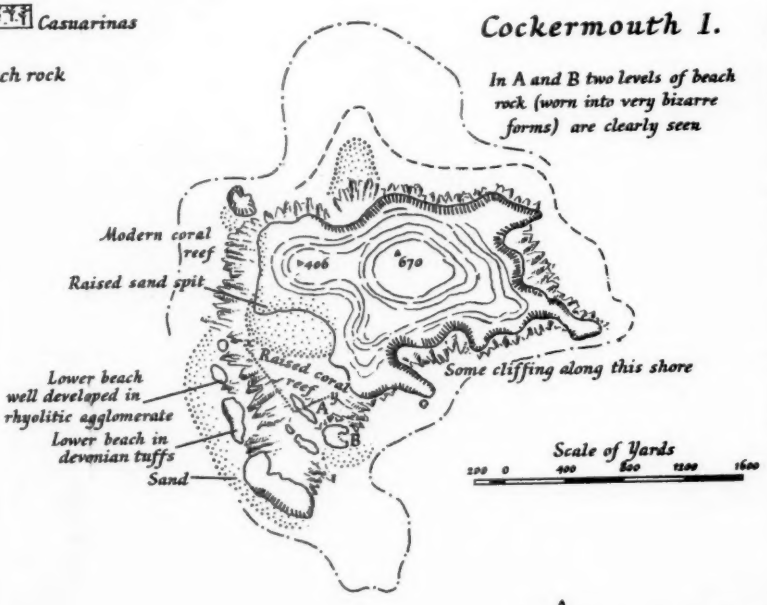
Sand and shingle flora

Casuarinas

Beach rock

Cockermouth I.

In A and B two levels of beach rock (worn into very bizarre forms) are clearly seen



Scale of Yards
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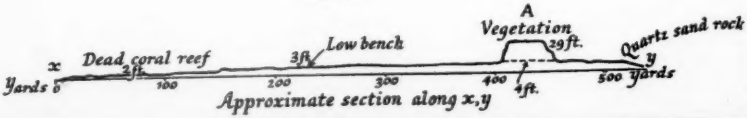

Approximate section along x,y

Gt BARRIER REEF
Steers